BEFORE THE PUBLIC UTILITIES COMMISSION
OF THE STATE OF CALIFORNIA

Order Instituting Rulemaking to Establish Policies and Cost Recovery Mechanisms for Generation Procurement and Renewable Resource Development.	Rulemaking 01-10-024 (Filed October 25, 2001)

WORKSHOP REPORT
ON VALUE AT RISK, CASH-FLOW AT RISK, AND OTHER MEASURES OF PORTFOLIO RISK ORDERED BY DECISION 02-12-074

WORKSHOP DATE: APRIL 23, 2003

Prepared by
Energy Division
June 6, 2003

Table of contents

I. Introduction

This report presents the results of a workshop conducted by the Commission's Energy Division on April 23, 2003. Ordering Paragraph 8 of Commission Decision (D.) 02-12-074 directed the Energy Division to schedule a workshop:

> "…that will assist the Commission in gathering information on Value at Risk and Cash-Flow at Risk models and to discuss a broader range of measures of portfolio risk exposure."

The following organizations made prepared presentations:

- Office of Ratepayer Advocates
- Henwood Energy Consultants
- Pacific Gas & Electric Company
- Southern California Edison Company
- San Diego Gas & Electric Company

This report summarizes and compiles the information that was presented during the workshop. Given that the Commission ordered the Energy Division to conduct an information-gathering workshop, this report seeks to meet that end by reporting factual information presented during the workshop. This report does not advocate a particular point of view for moving towards a probability-based assessment of risk.

Energy Division reserved a second workshop day for additional discussion. However, participants agreed that a second day was not necessary and that the final step should be the completion of the workshop report. This report is intended to meet the directive of Ordering Paragraph No. 8 of D.02-12-074 for Energy Division to conduct an information-gathering workshop.

II. Background

California's electric utilities once again entered the business of procuring electric power, energy, and ancillary products for their customers at the beginning of 2003. The Commission's procurement rulemaking proceeding, R.01-10-024, is establishing policies to guide utility procurement activities within the statutory framework of AB 57.

Assembly Bill 57

AB 57 of the 2001-2002 legislative session is the guide under which the utilities and the Commission are proceeding in procurement activities. At several points the legislation refers to matters associated with risk, including a statement that the utilities' procurement plans should include "risk management policy, strategy, and practices, including specific measures of price stability."[1] Because the legislation is directing the Commission and the utilities to engage in appropriate risk management, it is necessary to have an understanding of the risks that exist and how to measure portfolio risk.

Decision 02-10-062

In D.02-10-062, the Commission discusses risk management in several contexts, including among other things the need to establish a consumer risk tolerance level for the utilities' procurement portfolios. Specifically, the Commission noted that "Consumer risk tolerance defines the price that an average consumer would be willing to pay to reduce the risk of higher prices in the future (i.e., the cost-to-risk tradeoff)."[2] The decision also notes "Our objective is to create a procurement policy that ensures low and stable rates."[3]

Decision 02-12-074

Under the topic of Risk Management, D.02-12-074 adopts a consumer risk tolerance level for each utility and discusses using Value at Risk, Cash-Flow-at-Risk models and other tools to measure portfolio risk. The section notes that "Each utility proposes its own tools to measure portfolio risk."[4] It further states that "We agree with ORA that the utilities should move in the direction of analyzing portfolio risk based on a probability distribution of risk drivers but do not want to be prescriptive at this time in requiring the use of the VaR and CFAR models." The section then goes on to comment on each utility's portfolio analysis methods.

D.02-12-074 also requires the utilities to file a monthly risk management report that gives the utility's estimate of portfolio risk in the future, although the decision did not specify how risk should be quantified. All of the utilities have filed the required risk management reports for periods ranging from 1-5 years in the future. As reflected in

---

[1] Assembly Bill 57 of the 2001-2002 Session, Sec.(2)(b)(10).

[2] Public Utilities Commission of the State of California, *Interim Opinion*, Decision 02-10-062, note 16, page 42.

[3] Decision 02-10-062, cited above, page 42.

[4] Public Utilities Commission of the State of California, *Interim Opinion*, Decision 02-12-074, December 19, 2002, page 16.

these reports, PG&E and SCE calculate risk using proprietary models, and SDG&E calculates risk using a VAR-to-Expiration model. The utilities are currently using these risk calculations as a planning tool to assist them in making procurement decisions.

III. Summary of Results

The workshop began with Energy Division reading an excerpt from D.02-12-074 regarding portfolio risk measurement:

> "Each utility proposes its own tools to measure portfolio risk, as discussed in the confidential portion of their procurement plans. ORA recommends that the utilities should move in the direction of analyzing portfolio risk based on a probability distribution of risk drivers in lieu of the utilities' methodologies and specifically recommends the use of VaR and CFAR models.
>
> "We agree with ORA that the utilities should move in the direction of analyzing portfolio risk based on a probability distribution of risk drivers but do not want to be prescriptive at this time in requiring use of the VaR and CFAR models. We direct Energy Division to schedule a workshop in early 2003 that will assist us in gathering additional information on this subject and to discuss a broader range of measures of portfolio risk."[5]

The purpose of the workshop is to gather information so that the Commission may determine whether, and in what way, to move in the direction of analyzing portfolio risk based on a probability distribution of risk drivers. Some participants raised the related issues of risk management and consumer risk tolerance. If the Commission desires risk analysis to be reported, what will be done with the information, it was asked. Given the context of the establishment of a level of consumer risk tolerance, is it not reasonable to conclude that reporting of risk analysis will result in policy on risk management? Should we not discuss risk management when discussing risk analysis and reporting?

In another decision in this proceeding, the Commission established the objective to "create a procurement policy that ensures low and stable prices."[6] The issue of the analysis and reporting of portfolio risk cannot be completely separated from the issues of what the utilities will be directed to do to manage risk and what level of risk consumers are willing to bear in the search for low and stable rates.

Energy Division emphasized that this workshop is about analyzing risk so that risks can be understood and measured. It is not about managing risk and the rate impact of the outcome of risky events. Still, the question of what the utilities would be directed to do in response to reporting risk probability appeared in the presentations and frequently entered into the discussion.

---

[5] Public Utilities Commission of the State of California, *Interim Opinion*, Decision 02-12-074, December 19, 2002, page 16.

[6] Public Utilities Commission of the State of California, *Interim Opinion*, Decision 02-10-062, October 24, 2002, page 42.

Measuring Portfolio Risk Using Mathematical Models

An early step in risk management is developing an understanding of what the risks are. It would be helpful to have an understanding not only of the central expectation of what the future will look like, but also of how much the future is likely to deviate from the current expectation.

Organizations, such as the California utilities, that purchase or manufacture commodities for their customers are subject to a variety of risks that can affect the cost of their products. The California utilities operate their utility-retained generation (URG) power plants and must purchase fuel for some of those plants. They receive power on behalf of their customers from DWR contracts, whose costs are affected by gas prices. The utilities also purchase and sell electricity on their customers' behalf. For all of these items, the future costs include an element of uncertainty. Moreover, the utilities face uncertain demand conditions under which they may require either more or less of these commodities than planned, with consequent effects on price. Quantifying the risks implicit in a set of contracts requires an ability to measure the effects of likely and unlikely market changes. Probabilistic methods are the most effective tools for measuring risk and assigning specific probabilities to categories of outcomes.

There are several issues associated with this process. The following is a general accounting of the issues that were discussed, but not resolved, at the workshop:

- What is the best basis for analyzing the risk characteristics of the underlying risk drivers, such as the price of gas? Historical spot data? Historical forward data? Simulated data?
- Do we have confidence in the ability of analysts to discern the "shape" of the distributions, including the tails?
- Once risk drivers are defined and their risks quantified, what is the likely covariance among the risk drivers, and how is it determined, so that overall risk, the subject of the Commission's interest, can be quantified?
- Though it is possible to be confident about risk probabilities for very liquid and deeply traded commodities, especially over short periods, what is the effect on confidence levels when the products are not very liquid, are not deeply traded, and when we wish to develop longer range analyses?
- For analyses relating to time periods further into the future than typical market-trading activities, do we have confidence in calculating probability distributions?
- Though short-term risk analyses, such as for periods up to one year, may be robust, the uncertainties in longer term analyses are much greater. Is probabilistic analysis appropriate for multi-year forecasts?
- Reported risk measures may be auditable, in the sense that the utilities can provide back-up information to the Commission that will allow Staff to understand the results. But can risk analyses – relying, as they must on judgment – be objective, in the sense that other analysts would be likely to make the same judgments?

- Analyses of risk probabilities can be reviewed after the fact. What back-testing methods are appropriate?
- Extremely unlikely results are more difficult to model. What sensitivity analysis, scenario analysis, or stress-testing analysis methods are appropriate in measuring the risks faced by the California utilities?
- What will the Commission do with the information the utilities provide? Should this exercise be considered to be a preface for policy on risk management?

These questions arose throughout the day. They were not resolved in any formal sense, though there were several areas in which there appeared to be agreement among at least some of the participants. The most persistent issue, was, of course, about the Commission's plans for risk management and how this workshop on risk measurement helps to define or assist the Commission in setting policy on risk management.

Highlights of Comments Made During Discussion

During and between presentations, questions were posed to the presenters and to the Energy Division, and there was lively discussion. This section recounts the general flavor of opinions and positions expressed over the course of the workshop. There was no mechanism in place to determine whether all or how many participants agreed with these condensed points. No tally was taken.

- VaR, CFaR, and other mathematical methods of modeling risk are most useful for those time periods over which there are active and liquid markets for those elements that drive the risk, and over which the primary drivers of markets are relatively well known.
- Most often mentioned for reasonable time periods for analyzing risk through VaR and CFaR were periods of less than one year, including one day, one year, calendar, rolling 12-months and calculations of "to-expiration" periods of 12 months. The utilities indicated that they were willing to calculate risk for periods ranging up to five years.
- Analyses of risks over longer time horizons, such as five years or 20 years, must take into account myriad assumptions beyond the scope of current market information. For such analyses, the underlying information required for drawing conclusions from mathematical models is more speculative. Therefore, other methods of analyzing risk, such as scenario analysis, are more appropriate for long-range analyses.
- One appropriate cut-off point for risk analysis through modeling is the 95% confidence level. This is a conventional point for statistical testing. The shape of distribution functions at further extremes are not as well known and are more subject to modeling assumptions. More extreme events beyond the 95% confidence level may be considered. But it may be better to view them as "stretch" analyses, or extreme scenarios rather than as having specific percentage probabilities.
- Though participants expressed interest in the use of mathematical models for measuring risk, the question in the background was how the Commission will use the information reported to it and in what way the utilities should be acting to manage

reported risks. The utilities stated that they did not think that the results of risk analyses of this type are appropriate for dictating particular actions or inactions. ORA suggested that results be used to identify high-risk time periods.

IV. Participants' Presentations

There were six formal presentations at the workshop: two by ORA, and one each by Henwood Energy Consulting, Pacific Gas & Electric Company, Southern California Edison Company, and San Diego Gas & Electric Company. The presentations are included in this report as Attachments 5 through 10.

The main points from ORA's presentations are:

- VAR and CFAR models should be used as a planning tool to evaluate risk for the utilities' overall portfolio, rather than specific contracts.
- Without suggesting the exact form of VaR or CFaR to be used, ORA suggests a 5% significance level, leading to 95% confidence that the results will not be outside the bound identified by the analysis.
- Results can be used to inform the utilities and the Commission of time periods in which risk is increasing, in which case, utilities should reduce portfolio risk by executing appropriate hedges.

The main points from Henwood Energy Consulting's presentation are:

- Henwood Consulting strongly agrees that planning and hedging decisions beyond the current month should be made in the context of uncertainty, including volatility of fuel prices, spot markets, power plant outages, emissions, demand and hydro conditions.
- Stochastic simulation and the use of 'at risk' approaches are the best technique available to deal with such uncertainty.
- Although similar in approach, the lack of liquidity and complexity of electricity assets means that CFaR (sometimes termed a "VaR type metric") has significant advantages over a strict VaR approach.
- A robust estimation of CFaR can be estimated for generation assets and retail load taking account the unique problems associated with electricity market prices.

The main points from PG&E's presentation are:

- PG&E supports VaR approaches for quantifying portfolio risk exposure in the short-term procurement process as one input to managing the portfolio.
- PG&E believes To-expiration Value at Risk (TeVaR) is more appropriate for measuring risk over the rolling 12-month time horizon in the short-term procurement process. TeVaR measures risk over the entire holding period of the positions.
- PG&E advocates calculating a 95% confidence interval. More extreme calculations (such as 99%) are less stable because the shape of distribution functions at further extremes is not as well known.

- Reaching a particular VaR level should not dictate any particular action or inaction on the part of the utility, since VaR is only one measure of portfolio risk.

The main points from SCE's presentation are:

- SCE does not believe it can rely on a single risk metric for measuring portfolio risk or contract valuation. Rather, it would attempt to use a series of parametric, probabilistic, and statistical tools, in addition to prudent judgment, to make procurement decisions.
- Oversimplified assumptions pertaining to operating constraints (such as ramp rates, minimum start-up and shut-down times, start-up costs, etc.) can result in VAR or CFAR calculations that take on various magnitudes of errors, even in excess of 200% based on results from some of SCE's modeling attempts.
- The mathematical tools should be considered research related, and they should be allowed to evolve. Well defined procurement objectives can help to ensure that proper tools are being developed and implemented.
- SCE is concerned about how the Commission may want utilities to act on any risk metrics that are produced.

The main points from SDG&E's presentation are:

- VAR modeling is just one of many ways to model portfolio risk. In fact, SDG&E computes and tracks several risk measures.
- It is not appropriate for use over longer horizons such as 5 years or longer, for sufficient price transparency and market liquidity do not exist over such long time frames, and no remedial action may be available.
- SDG&E's analyses rely on a 95% confidence level.
- Since SDG&E's VAR model quantifies its portfolio risk based on volatility and correlation of gas and power markets, SDG&E can trade the underlying gas and power prices (via physical and financial products) to manage portfolio risk.

Each organization provided its own brief summary of its presentation, included here, as written.

Office of Ratepayer Advocates

Summary of ORA's VAR and CFAR Presentations

By Jan Reid and Christine Tam

On April 23, the Office of Ratepayers Advocates (ORA) made presentations on Value at Risk (VAR) and Cash Flow at Risk (CFAR) at a Portfolio Risk Workshop sponsored by the Energy Division. The VAR model estimates the maximum loss that could occur for a given time period. The CFAR model estimates the maximum cash shortfall (relative to a specific target) that could occur in a given time period. Both the VAR and CFAR models are calculated at a specific significance level (usually 5%). A significance level of 5% indicates that we are 95% confident that the maximum loss (or cash shortfall) will not exceed the amount estimated by the VAR or CFAR models in the specified time period.

ORA believes that the utilities should measure portfolio risk using either VAR or CFAR. However, ORA's does not wish to proscribe the exact form of VAR or CFAR that should be used. Instead, ORA presented background material on VAR and CFAR, described how these models could be implemented, recommended a general implementation of the models, and proposed that a 5% significance level be used in determining portfolio risk.

ORA also recommended that the utilities calculate portfolio risk on a monthly basis in the current year, a quarterly basis for the second year, and on an annual basis for the following four years.

The VAR and CFAR models should be used as a planning tool to evaluate risk for the overall portfolio rather than specific contracts. Results can then be used to inform the utilities and the CPUC of the specific time periods in which risk is increasing. The utilities should then pay particular attention to such time periods, and reduce portfolio risk by executing the appropriate forward, option, and derivative contracts.

Either the VAR or CFAR models could be used to prevent the utilities from hedging electricity price risk in certain time periods. If the Commission wished to do this, it would set a maximum VAR or CFAR and order the utilities not to hedge unless the estimate was above the maximum level. ORA does not believe that such prohibitions would be appropriate since the models will be estimated with an unknown amount of model error and the estimated risk may be different than the actual realized risk.

ORA views VAR and CFAR results as a set of numbers that indicate the relative risk in different time periods (e.g., October 2003, 1st quarter 2004, 2005, etc.). If used in the way suggested by ORA, the VAR and CFAR models can be a valuable tool that will allow us to reduce risk on behalf of both ratepayers and shareholders.

Henwood Energy Consultants

Summary of Henwood Energy's Presentation

This note sets out and develops the key points made during Henwood Energy's presentation at the above meeting. It is intended to complement the actual presentation.

In summary we make the following key points:

- We strongly agree that planning and hedging decisions beyond the current month should be made in the context of uncertainty, including volatility of fuel prices, spot markets, power plant outages, emissions, demand and hydro conditions.
- That stochastic simulation and the use of 'at risk' approaches are the best technique available to deal with such uncertainty.
- Although similar in approach, the lack of liquidity and complexity of electricity assets means that CFaR (sometimes termed a "VaR type metric") has significant advantages over a strict VaR approach.
- That a robust estimation of CFaR can be estimated for generation assets and retail load taking account the unique problems associated with electricity market prices.

Introduction – Why are we here?

Henwood Energy is a global software and consultancy business. Our software and/or consultancy services have been used by over many of the leading US utilities to support their planning, RFP and hedging decisions for over a decade. This experience includes the three major Californian Utilities as well as a significant number throughout the world. Henwood Energy sell two products that are widely used in this are MARKETSYM and RISKSYM. The latter product helps utilities directly evaluate the risk of their portfolios under uncertainty and provide will calculate the CFaR for complex asset portfolios.

Henwood has participated in this forum for two reasons. Firstly, as an entity that has devoted a large effort to designing software to help Load Serving Entities evaluate their risk positions we believe we have something to offer to this discussion. Secondly, we are interested in furthering our understandings of these risk matters by listening to the other participants.

What Risks are we looking at?

Any types of risks can be 'hedged' (some more easily than others) through insurance or other risk management techniques. We are not talking today about every risk facing a utility today that they need to manage. Here we are talking about the financial risks that directly impact on the future cash flow of the business due to the market uncertainty facing the major supply costs of fuel, the uncertainty of revenue due to fluctuations in market prices, ability to produce the product volatility in the demand for the product. We are thus not talking about legal, human, safety risk, regulatory, technological or 'load departing' risks. Although stochastic processes can and are often are applied in these areas.

Stochastic, the why and what

What is a stochastic approach? Even as professional forecasters, we believe the future cannot be accurately predicted. Volatility can and will occur. Certain drivers of volatility can be characterized realistically with carefully developed volatility parameters. Utility planners have recognised this for years, but have not always had the tools at hand to deal systematically with this uncertainty. A stochastic approach using 'Monte Carlo' allows you to create 100's or even thousands of alternative potential outcomes, each equally probable. With this you can assess the performance and resultant financial impact of you portfolio under each and every case and then describe the outcomes as a distribution. As such it is ideally suited to calculating downside risk, the worst that is likely to happen if market prices move against you. For instance it allows you to estimate the probability of losing say more than $1million over the next 12 months.

This approach is particularly important for any assets that are not linear or symmetrical in the way they operate. For instance power stations often shut down when the market can supply electricity cheaper from another source. This means they continue to make more money as prices rise, but there is a floor on their downside losses. This 'optionality' is very valuable but deterministic approaches (producing a single or small number of forecasts) do not recognise this value and the resultant impact it has on the portfolio. As such a deterministic approach can lead to an incorrect hedging strategy where 'optionality' exists in the portfolio.

Comparing VaR and CFaR

The other presenters have done an excellent job setting out the framework for VaR and CFaR and the alternative approaches to calculating them.

VaR was developed for liquid financial markets and at its core it assumes you can mark your future position to prevailing market prices and that you are able to completely hedge your assets within a defined holding period. While TeVaR extends VaR to account for assets you intend to hold to expiration it does not explicitly look at the cash flow effects of this period by period into the future.

The comparative table in our presentation sets out the key differences between VaR and CFaR. A comparison of the list of utility attributes with the table showing the differences between VaR and CFaR indicates why we would strongly advocate any risk system related to an electric utility should include a CFaR approach.

Issues associated with calculating CFaR/VaR in the power market

‘At risk’ approaches are based on assumptions about statistical parameters. For instance the most assumption in calculating VaR is that prices will follow a ‘normal random walk’. There is not the space here to discuss these issues at length but in summary electricity spot prices do not follow this simple assumption of normality. This is not a new revelation, many academics and practitioners have been wrestling with these issues for many years now and much progress has been made. At Henwood Energy we have been following this area closely and have developed our own models to address the issues. For example, we offer the ability to model prices using a regime switching Markov distribution which we feel offers one of the best approximations to the actual behaviour of market prices.

The other major issue is accurately representing the assets in the models. Including the dispatch-ability of power stations. This is a major computative problem, particularly when considering run time. Again, however it is one where solutions exist.

Is this a practical solution?

The simple answer is yes. Admittedly after significant investment in research and system development, Henwood has successfully applied this approach on a number of occasions. In particular our RISKSYM model (or any other similarly designed model) provides a practical solution to the major hurdles in calculating CFaR and can be used for other ‘at risk’ or even deterministic approaches.

Pacific Gas & Electric Company

PG&E's Value-at-Risk Approach

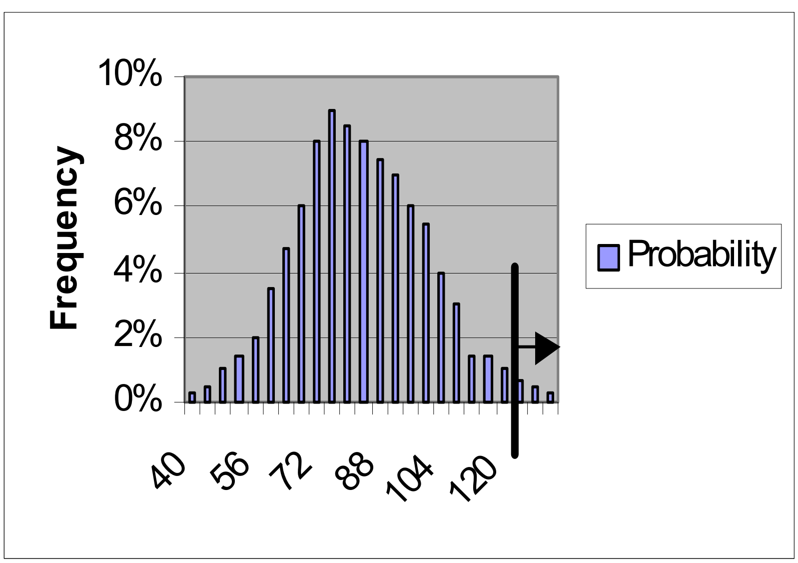
Value-at-Risk (VaR) is a measure of the maximum potential change in the value of a portfolio with a given probability over a pre-set time horizon.

PG&E supports Value-at-Risk (VaR) approaches for quantifying portfolio risk exposure in the short-term procurement process, as one input to managing the portfolio. As part of measuring portfolio risk, some of the factors to consider are:

- The risk drivers being measured
- The calculation method
- The VaR period
- Confidence interval

Risk drivers - PG&E's portfolio contains risks beyond market positions in electricity and gas. Other major risks associated with holding this portfolio include hydro generation and load. The risk due to these drivers should be explicitly measured along with electric and gas price risk.

Calculation method – PG&E computes its VaR using a simulation process, where each of the risk drivers can take on a distribution of values, which can have any shape beyond a statistically normal distribution. Therefore, the distribution of risk can be non-linear.



An alternative to a calculating VaR using simulation is to use a Variance-Covariance calculation, which produces linear VaR results. One limitation to that approach is that if a portfolio contains a significant number of non-linear positions (such as options), the approach may not be ideal for representing total portfolio risk. Therefore, PG&E supports use of a linear VaR approximation for testing hedge transactions and evaluating sub-portfolio risks, but a simulated VaR for representing total portfolio risk.

VaR period – PG&E recognizes that a useful application for VaR measurement is for the short-term procurement process, currently focused on managing portfolio exposure over a rolling 12-month time horizon. Given that this portfolio must essentially be taken to physical delivery, the appropriate VaR period is the entire holding period (12 months). The term used for measuring risk over the entire holding period is To-expiration VaR or TeVaR. This is in contrast to a daily VaR, which is a more common period measure of VaR for portfolios containing commodities that can be quickly unwound.

Confidence interval – PG&E advocates that TeVaR generally be calculated using a 95% confidence interval (one tail is 5%), which is somewhat common. Calculations using more extreme % tails can be less stable because the outcome distributions can contain long tails. Instead, TeVaR results should be complemented with additional stress scenarios so that a well-defined and broad range of risk exposure outcomes can be examined.

Use of TeVaR -- PG&E intends to report TeVaR on a regular basis to the Procurement Review Group. TeVaR is just one measure of portfolio risk. Reaching a particular TeVaR level should not dictate any particular action.

SOUTHERN CALIFORNIA EDISON COMPANY'S SUMMARY TO THE ENERGY DIVISION ON ITS 4-23-03 RISK METRIC WORKSHOP PRESENTATION

Risk Tools and Models

Southern California Edison Company's (SCE) presentation defined risk tools as simple algorithms or calculations and risk models as a compilation of various risk tools to simulate the operation of identified risk events. To further the understanding of the tools and models, SCE groups risk tools into the following categories:

i) parametric tools – equation-based algorithms with constant parameters where a single and unique X-valued input yields a specific Y-valued output;

ii) probabilistic tools – distribution-based tools where a distribution of X values generate a distribution of Y values; and

iii) statistical tools – numerical values, such as standard deviation or mean, that characterize the sample or population from which it was derived. More sophisticated statistical tools include regression based analysis.

SCE noted that some tools may not fit cleanly into one category of tools. Additionally, risk models can be developed using one or more categories of these tools. Value at Risk (VaR), for example, can be estimated using parametric and statistical tools (Linear-VaR), or can be estimated probabilistically by simulation process (Simulated VaR). Similarly, Cash Flow at Risk (CFaR) models can use various tools.

Constraints in Tools and Models

SCE emphasized that oversimplified assumptions can significantly skew model results. Examples of contract constraints that are often oversimplified are ramp rates, minimum start-up and shut-down times, maximum run-times, start-up costs, emission constraints, capacity factors, delivery specifics, and so on. SCE presented the results of some of its contract valuations with and without operating constraints modeled, and indicated that the results deviated from 20% to levels in excess of 200%. Thus, any resulting VaR or CFaR calculations could also take on these magnitudes of error. SCE is actively experimenting with VaR models in hopes of controlling for the numerous technical hurdles, but SCE is also concerned with unintended applications of such models.

Suite of Tools

SCE informed the workshop participants that it is evaluating VaR and CFaR, as well as other tools and risk models, and that this type of analysis must be considered research-related and allowed to evolve. SCE indicated that it did not believe it could rely on a single risk metric for portfolio risk measurement or contract valuation. Instead, SCE would attempt to use a series of parametric, probabilistic, and statistical tools, in addition to prudent judgment, to make procurement related decisions. As a result, SCE recommended that procurement plans provide utilities with flexibility in managing their procurement portfolios.

Guiding Principles of Using the Risk Metrics

SCE addressed the implications of using VaR and/or CFaR risk metrics, or any other risk metric that is estimated. Namely, how does the Commission want utilities to act on any risk metrics that are produced? At the end of the day, risk metrics require an arbitrary decision as to how they should be applied and acted upon. That decision should come from the risk appetite of a utility's ratepayers, and identifying a societal risk appetite is problematic.

SCE also pointed out the need for a set of guiding principles with regard to risk metrics, their use, and fundamental assumptions underlying regulatory decisions. Specifically, SCE discussed the need to define a utility's procurement objective (i.e., is it portfolio cost risk management or meeting a reliability criteria?) to avoid incompatible charters and to ensure that proper tools are being developed and implemented. Additionally, SCE makes regulatory assumptions that CDWR contract costs must follow the CDWR contract allocation ("costs follow contracts") to ensure that a utility's hedging activity benefits its ratepayers.

The follow-up discussion on SCE's message was very energetic. Some made comments that SCE's presentation and perspective was "refreshing" and "brutally honest."

San Diego Gas & Electric Company

Summary of April 23, 2003 SDG&E Presentation

VaR modeling is just one of many ways to model portfolio risk. It incorporates anticipated changes to market prices that affect portfolio value (or in SDG&E's case, cost). It is appropriate to incorporate VaR modeling when action can be taken to manage portfolio risk WITH THE INPUTS USED IN THE MODEL. In other words, because the VaR model quantifies SDG&E's portfolio risk based on volatility and correlation of gas and power markets, SDG&E can trade these underlying gas and power prices (via physical and financial products) to manage portfolio risk.

To emphasize, in order to use VaR meaningfully one must be able to lock in the price whose volatility is creating the risk. This assumption is valid given adequate market liquidity (which includes credit and total volumes traded) of the products whose prices are used (6x16, Nymex and basis, etc). Given SDG&E's position of good credit and manageable open position size, the VaR model is appropriate for SDG&E to use on a rolling 12-month basis and possibly through the following calendar year (i.e. within the period covered by SDG&E's short-term procurement plans).

VaR modeling is NOT appropriate for use over longer horizons such as 5 years or longer. Currently, sufficient price transparency and market liquidity do not exist to use VaR modeling for longer time frames, especially in the gas basis and forward power markets. Even if the VaR model indicated exceeding the risk exposure limit, no cost-effective remedial action may be available. For longer periods, for example years T+3 through T+10, traditional resource planning which results in infrastructure additions and L/T contracts is probably more appropriate at this time.

SDG&E's presentation focuses on describing how it makes use of VaR, rather than a technical explanation of how to calculate VaR. SDG&E describes VaR to Expiration as one component in quantifying a "stop loss" for use in providing guidance in risk management decisions. Total costs for the year are calculated each day (actual costs for "closed" months, Mark-to-Market costs for "open" months). VaR is added to this to calculate maximum projected costs (at a 95% confidence level). This is compared to a baseline of forecasted costs plus Customer Risk Tolerance (stop loss).

While SDG&E uses VaR to Expiration, there are other VaR methods available. It is important to realize that 1) the VaR method chosen is not as important as the consistent application of the method chosen (although SDG&E feels that VaR to EX is the method best matched to its portfolio and risk); and 2) different VaR methods will produce very different measures of the same underlying risk. It is essential to understand what the different VaR models are measuring and to make appropriate use of the VaR measurements (for instance, when trying to determine ORA's cost/benefit test for hedging).

SDG&E also discussed its modeling of CfaR, which is similar to "headroom" in the ERRA account. Retail revenues available to book toward ERRA costs are residual - that is, the amount available is total revenue less remittances to CDWR. Calculation of the headroom is very difficult in light of the potential "true-ups" to CDWR revenue requirements that are impossible for SDG&E to model because they are unknown.

V. Procedural Timeline

- D.02-12-074 directed the Energy Division to schedule a workshop in February 2003.
- On February 28, 2003 the Energy Division requested an extension of time to schedule the workshop in April. The Commission's Executive Director approved this request on March 5, 2003. Notice of the approval was served electronically on parties in Rulemaking R.01-10-024 on March 6, 2003.
- On April 4, the service list for Rulemaking R.01-10-024 received notice of the upcoming workshop (Attachment 1). The Commission's Daily Calendar announced the workshop on April 7 (Attachment 2). Parties who wished to make presentations were invited to contact the Energy Division by April 14. The Office Ratepayer Advocates (ORA), Henwood Energy Consultants, and the three California investor-owned electric utilities contacted the Energy Division about making presentations. A proposed agenda was circulated to the service list on April 17 (Attachment 3).
- The workshop was held on April 23 at the State Civic Center Complex. Attachment 4 presents a list of the attendees.
- Presentations made at the workshop were posted in electronic form on the Commission's website on April 30. (They are also included in this document as Attachments 5 to 10.) The link is:

  http://www.cpuc.ca.gov/static/industry/electric/workshop4_23_2003.htm
- Energy Division requested presenters to submit summaries of their presentations on May 5. All summaries were received by May 7. They are included in the text of this document. On May 12, Energy Division circulated a draft report to workshop participants for suggested edits. Written edits were due back to Energy Division on May 20, 2003.
- Comments were received from ORA and from PG&E.
- This final report was issued on June 6, 2003.

Attachment 1 – Notice of Workshop

From: St. Marie, Stephen
Sent: Friday, April 04, 2003 2:47 PM
To: (Service List)
Subject: Notice of Workshop in Procurement Proceeding (R.01-10-024)

Pursuant to CPUC Decision 02-12-074 in the Procurement Rulemaking Proceeding, (R.01-10-024) the Energy Division has scheduled a workshop on Value at Risk and Cash-Flow at Risk models and to discuss a broader range of measures of portfolio risk exposure.

The workshop is to take place in San Francisco at the State Building, 455 Golden Gate Avenue, Meeting Room 9 on April 23, 2003, starting at 10:00 a.m., concluding by 4:00 p.m. Should it be necessary to continue the workshop for a second day, the Energy Division has reserved April 30 at the same facility.

The announcement will appear on the Daily Calendar of April 7, 2003.

Parties that wish to make a presentation at the workshop should contact Energy Division Staff by April 14. Staff Contact is Stephen St. Marie, 415-703-2317, sst@cpuc.ca.gov.

A workshop agenda will be forthcoming.

Attachment 2 – Announcement of Workshop

Public Meeting Notice – Workshop on Energy Portfolio Risk Measures (R.01-10-024)

April 23, 2003 *10:00 am – 4:00 pm*	*State Building* *455 Golden Gate Avenue* *Meeting Room 9* ***San Francisco***

Ordering Paragraph 8 of Decision 02-12-074 directs the Commission's Energy Division to:

> "…schedule a workshop in February 2003 that will assist the Commission in gathering information on Value at Risk and Cash-Flow at Risk models and to discuss a broader range of measures of portfolio risk exposure."

On February 28, 2003 the Energy Division requested an extension of time to schedule the workshop in April. The Commission's Executive Director approved this request on March 5, 2003. Notice of the approval was served on parties in R.01-10-024 on March 6, 2003.

The Energy Division has scheduled the workshop to take place in San Francisco on April 23, starting at 10:00 a.m., concluding by 4:00 p.m. Should it be necessary to continue the workshop for a second day, the Energy Division has reserved April 30 at the same facility.

A workshop agenda will be forthcoming.

Parties that wish to make a presentation at the workshop should contact Energy Division Staff by April 14.

Staff Contact: Stephen St. Marie, 415-703-2317, sst@cpuc.ca.gov.

Attachment 3 – Workshop Agenda

California Public Utilities Commission

R.01-10-024

<u>Workshop</u>

Value at Risk, Cash Flow at Risk
And Other Measures of Portfolio Risk

April 23, 2003, 10:00 a.m.

State Civic Center Complex
455 Golden Gate Ave, San Francisco
Meeting Room 9

Preliminary Agenda

Introduction

Who is Here and Why We Are Here

Presentations

Office of Ratepayer Advocates

<u>Value at Risk – Jan Reid</u>

<u>Cash-Flow at Risk – Christine Tam</u>

Henwood Energy Services

Pacific Gas and Electric Company

Southern California Edison Company

San Diego Gas & Electric Company

Discussion

Next Steps

Attachment 4 – List of Workshop Attendees

Affiliation	Last Name	First Name
Cal Energy Mkts	Weinzimer	Lulu
CEC	Belostotsky	Albert
CEC	Benjamin	Rich
CEC	Gopal	Jairam
CEC	Vidaver	Dave
CFBF	Liebert	Ron
CPUC-Energy	Atamturk	Nilgun
CPUC-Energy	Chan	Amy
CPUC-Energy	Fulcher	Jack
CPUC-Energy	McCartney	Wade
CPUC-Energy	St. Marie	Stephen
CPUC-Energy	Wetstone	Brad
CPUC-ORA	Hassanpour	Mohammad
CPUC-ORA	Reid	Jan
CPUC-ORA	Smith	Don
CPUC-ORA	Tam	Christine
DWR-CERS	Brow	Bob
DWR-CERS	Hargan	Garney
EPG	Mobasheri	Fred
Henwood Energy	Henwood	Mark
Henwood Energy	Lauckhart	Rich
Henwood Energy	Thain	Grant
Navigant Consulting	Nichols	Nick
NRDC	Bachrach	Devra
PA Consulting Group	Jacops	Jonathan
PG&E	Belyaev	Victor
PG&E	Bogy	John
PG&E	Burns	Sandy
PG&E	Chiu	Grace
PG&E	Jeung	Gary
PG&E	Loh	Vincent
PG&E	Pestana	Harold
PG&E	Singh	Amrit
PG&E	Suri	Anil
PG&E	Winn	Valerie
PG&E	Woo	Shirley
PG&E-NEG	Hsu	Eric
SCE	Alvarez	Manuel
SCE-ES&M	Chaudhury	Sharim
SCE-ES&M	Cushnie	Colin
SCE-ES&M	Jurewitz	John
SCE-ES&M	Quinn	David

SCE-ES&M	Ulrich	Marc
SDG&E	Choi	Tony
SDG&E	Kloberdanz	Joe
SDG&E	Lorenz	Lad
SDG&E	McClenahan	Mike
Self	Derby	Stephen
SMUD	Cai	Yong
TURN	Florio	Mike
Woodruff Expert Svcs	Woodruff	Kevin

Attachment 5 – Presentation of ORA on Value at Risk

Office of Ratepayer Advocates

Value at Risk (VAR)

By Jan Reid
(415) 703-1546
ljr@cpuc.ca.gov

April 23, 2003

1

Topics

2

Background of Risk Measurement in R.01-10-024

- ORA proposed that reasonableness be based on a rules based analytical system using either value at risk (VAR) or cash flow at risk (CFAR). (May 2002)
- ORA proposed that the utilities be required to use either VAR or CFAR to measure overall portfolio risk. (December 2002)
- D.02-12-074 (p.16) ordered that the Energy Division hold a workshop to gather information on VAR, CFAR, and other risk measurement models.

3

Current Situation

- SDG&E uses a VAR-to-expiration model.
- SCE uses a proprietary model.
- PG&E uses a proprietary model.

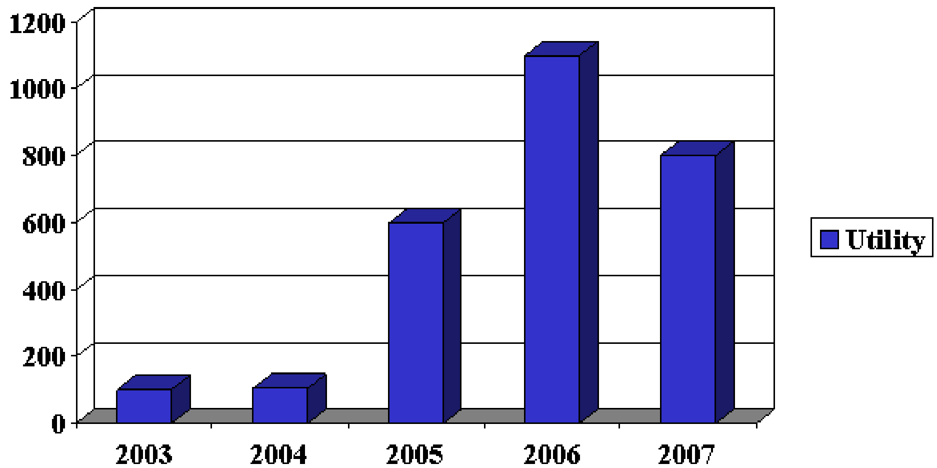
Risk Management History

- **1935:** Put and Call Brokers and Dealers Association was formed.
- **1973:** Black-Scholes Model was developed.
- **1973:** Chicago Board Options Exchange was formed.
- **1992:** Indiana Court of Appeals found that organizations have an obligation to hedge on behalf of their shareholders.
- **1994:** VAR model developed by J.P. Morgan

Risk Measurement Goals

- Standardization across Utilities
- Should be Probabilistic
- Not required to map to rates
- Provides Regulators and Utilities with a set of relative numbers that can be compared over time
- Allows Regulators and Utilities to be able to identify time periods when risk is projected to increase and to take appropriate action

Portfolio Risk Over Time



7

Linear VAR Model

- Assumes that changes in the value of the portfolio are linearly related to changes in the underlying market variables
- Assumes that changes in the underlying market variables are normally distributed
- Can be safely used when no options or fully dispatchable capacity contracts are part of the portfolio
- Forms the basis of the Quadratic VAR Model

8

Linear Formulas (95% confidence)

$$\sigma_{\Delta A} = \mathrm{Val}_A \mathrm{Vol}_A d^{0.5}$$

$$\sigma_{\Delta B} = \mathrm{Val}_B \mathrm{Vol}_B d^{0.5}$$

$$V_A = 1.65(\sigma_{\Delta A})$$

$$V_B = 1.65(\sigma_{\Delta B})$$

$$\sigma_{(A+B)} = (\mathrm{var}_A + \mathrm{var}_B + 2\rho\sigma_A\sigma_B)^{0.5}$$

$$V_P = 1.65[\sigma_{(A+B)}]$$

Linear Formulas (continued)

Where:

$\sigma_{\Delta A}$ and $\sigma_{\Delta B}$ are the standard deviations of the change in assets A and B.

Val_A and Val_B are the values of positions A and B in dollars.

Vol_A and Vol_B are the volatilities of assets A and B.

d is the number of days.

V_A and V_B is the VAR of positions A and B.

var_A and var_B are the variances of assets A and B.

ρ is the correlation coefficient between A and B.

V_P is the value at risk of the portfolio.

10

Estimating Correlation and Volatility

- **Option prices:** Calculate using traded option contracts.
- **Forward prices:** Use a time series of forward prices.
- **Spot prices:** Use a time series of spot prices.
- **Structural models:** A structural model (e.g., ARCH models) of the commodity market can be used to estimate correlation and volatility.

Creating Probability Distributions

When the actual probability distribution is non-normal (as is the case for most distributions) a representative distribution must be created using either:

1. Monte Carlo Simulation
2. Cornish-Fisher Expansion. The mean and standard deviation are taken from the Quadratic Model and are used in the Cornish-Fisher Expansion to create the third moment (skewness).
3. Hull-White Method. See "Value at Risk When Daily Changes are not Normally Distributed," *Journal of Derivatives*, Vol. 5, No. 3, pp. 9-19.

Monte Carlo Simulation

Monte Carlo Simulation can be used to obtain the probability distribution for ΔP (change in portfolio value). To calculate a one-day VAR:

1. Value the portfolio using the current values of market variables.
2. Sample once from the normal probability distribution of each variable (x_is) and use these values to determine the value of each market variable at the end of the day.
3. Revalue the portfolio at the end of the day
4. Subtract the value calculated in step 1 from the value calculated in step 3 to determine a sample ΔP.
5. Repeat steps 2 and 3 many times (e.g., 10,000) to build up a probability distribution for ΔP and build a distribution table.

Quadratic VAR Model

- Should be used when options are part of the portfolio.
- Accounts for Gamma (γ), the rate of change of delta with respect to the market variable.
- The probability distribution of ΔP is positively skewed when gamma is positive and negatively skewed when gamma is negative.
- A long call position typically has a positive gamma and a short call position typically has a negative gamma.
- Calculation of VAR is highly dependent on the left tail of the distribution.

Quadratic Formulas

Portfolio value is dependent solely on commodity S.

$$\Delta P = \delta \Delta S + 0.5(\gamma \Delta S^2)$$

Portfolio value is dependent on a number of variables (S_is)

$$\Delta P = \sum S_i \delta_i \Delta x_i + \sum 0.5[(S_i)^2 (\gamma_i)^2 \Delta (x_i)^2$$

where Σ is the sum from i=1 to n, δ_i and γ_i are the delta and gamma with respect to the *ith* market variable.

15

Implementation

1. Initially, assume that RNS will be procured in the spot market.
2. Calculate VAR using a 5% probability.
3. Use the Quadratic model in combination with either the Cornish-Fisher expansion or Monte-Carlo simulation.

Definitions

Arbitrage is a zero-risk, zero-net investment strategy that still generates profits.

An **autoregressive model** is a forecasting model in which one uses the statistical properties of the past behavior of a variable to predict its behavior in the future. (i.e., Y = c + b[Y(–1)])

The **Black-Scholes model** is primarily used to value stock options. The model uses the option strike price, forward price, and volatility of prices. The extended model assumes: (1) markets are efficient, (2) returns are lognormally distributed, and there are no arbitrage opportunities.

Definitions (continued)

A **Cap** is the maximum price to be paid for a commodity in a derivatives contract.

Cash Flow at Risk (CFAR) is a measure of uncertainty about future cash flows to a portfolio. CFAR gives the maximum shortfall within a specified confidence level (e.g., 95%) of the cashflows anticipated in a given planning period (e.g., July, 2003).

Collars specify both the upper and lower price limits for a commodity.

The **contract price** is the pre-determined price.

The **contract quantity** is the fixed quantity (e.g., 500 MW).

Definitions (continued)

The **efficient market hypothesis** states that it is impossible to beat the market because prices already incorporate and reflect all relevant information.

The **exercise date** is the designated date in a forward or option contract.

A **floor** is the minimum price to be paid for a commodity in a forward or option contract.

A **forward curve** is a graph of estimated or actual forward prices over time.

A **forward long contract** is a contract to buy a commodity.

Definitions (continued)

A **forward short contract** is a contract to sell a commodity.

A **forward call option** is the right to buy an asset at a specific exercise price on or before a specific exercise date.

A **forward put option** is the right to sell an asset at a specific exercise price on or before a specific exercise date.

Gamma is the rate of change of the price of a portfolio of options with respect to the price of the underlying asset(s).

A **hedge is** a trade designed to reduce risk.

Definitions (continued)

Market risk is the uncertainty of future financial results due to changes in market rates and prices.

Monte Carlo simulation is a procedure for randomly sampling changes in market variables in order to value a contract or derivative.

An **option** gives the party the right to buy or sell a commodity at a future time for a specific price.

Rho is the rate of change of the value of a portfolio with respect to the interest rate.

Risk is the uncertainty of future prices.

Definitions (continued)

Risk Management is a set of strategies employed by firms and regulators to reduce the exposure of shareholders and ratepayers to uncertainty.

Skew is a measure of the distribution of a series around its mean.

Speculation is the act of investing with the intent of realizing a profit.

The **strike price** is the contract price. This is sometimes called the exercise price.

A **Swap agreement** is a contract that involves the exchange of physical commodities or cash flows according to a predetermined formula.

Definitions (continued)

Theta is the rate of change of the value of a portfolio as time passes. This is also referred to as the time decay of the portfolio.

The **underlying asset** is the asset on which a forward contract or option contract is written.

Value at Risk (VAR) is a measure of uncertainty about the future value of a portfolio. VAR measures the maximum loss within a specified confidence level (usually 95%) if the portfolio is held for a certain length of time.

Definitions (continued)

The **variance** of an asset's return is the expected value of the squared deviations from the expected return.

Vega is the rate of change of the value of a portfolio with respect to the volatility of the underlying asset(s).

Volatility is a measure of the uncertainty of the return realized on an asset. If volatility is to be expressed annually and monthly data is used, volatility is the standard deviation of returns multiplied by the square root of 12.

Attachment 6 – Presentation of ORA on Cash-Flow at Risk

Cashflow-at-Risk

Office of Ratepayer Advocates
Christine Tam
tam@cpuc.ca.gov
415-355-5556

April 23rd, 2003

1

Definition

What is Cashflow-at-Risk (CfaR)

- Definition:

  "The maximum shortfall of net cash generated, relative to a specified target, that could be experienced due to the impact of market risk on a specified set of exposures, for a specified reporting period and confidence level" (1)

- Within the context of electric utility procurement, CfaR can be used to gauge expense level at the worst-case scenario given the portfolio's net short position

- Variable cashflow components include spot purchases for electricity and fuel, hedging expenses, etc.

(1) Source: RiskMetrics Group (spin-off from J.P. Morgan). This presentation is based on their CorporateMetrics framework to measure market risk for non-financial corporations.

2

Methodology

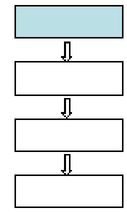
General Approach

Cashflow Mapping	Identify all the input variables (or cashflow components) subjected to market risk that go into the cashflow equation.
⇩	
Market Rate Forecast	Specify a set of future dates and obtain the forecast distributions of the cashflow components for each of these dates
⇩	
Scenario Simulation	Use Monte Carlo simulation to generate scenarios based on the joint distributions of the cashflow components
⇩	
Risk Estimation	Calculate the risk measure under each scenario; based on the simulation results, determine the value of cashflow-at-risk

3

Methodology

Cashflow Mapping



- Market variables that affect procurement expenses:
  spot price (energy/gas), forward price (energy/gas), interest rate…

- An example of a cashflow map:
  Energy Procurement Expenditure in May'03
  (unhedged position)
  = spot electricity price to cover net short energy
  + spot gas price to cover fuel cost of tolling contracts

4

Market Rate Forecast

- Problem: forecast the mean and variance of the probability distribution of one or more market variables

- Two approaches to estimating market rate distributions:

  (1) Extrapolate from current market information
  - the "Efficient market hypothesis" implies that market expectations are embedded in current market prices
  - Example: estimate mean values of future spot price from forward prices; estimate variance based on market rate volatility

  (2) Econometric modeling
  - Construct econometric forecasting model based on historical information
  - Single variable or multivariate autoregressive model e.g. $x_{(t)} = a + b^{*}x_{(t-1)} + c^{*}y_{(t-1)}$
  - Limitations: difficult to define the functional form of the model; may not work too well for non-storable goods with high degree of seasonality

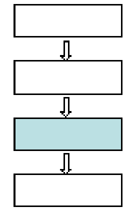
5

Market Rate Forecast (cont'd)

- Estimating market volatility
  - Implied volatility based on current option price
    - Derived from the Black-Scholes option pricing model
    - useful for comparing options
  - Forecast volatility based on forward price curve
    - may not be accurate if the market is thinly-traded
  - Historic volatility based on historic prices
    - volatility is derived from a rich set of historic prices
    - Will depend on the time period chosen for the calculation

6

Scenario Generation

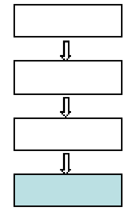


- Based on the forecast results of the market rate distributions, build covariance matrix to take into account the joint fluctuations of prices at different time horizons [(2)]
  - Price correlation across multiple periods
    - Example: construct a 3 x 3 covariance matrix for the price of gas at 3 forecast periods (expressed in terms of the variance forecasts)
  - Cross correlation between market variables
    - Example: construct a 3x3 cross covariance matrix for the price of gas and electricity over 3 forecast periods (need to estimate correlation coefficient between the two market variables)

- Given the expected values of the market variables and the covariance matrix, run Monte Carlo simulations to generate prices at the forecast dates

(2) See calculation details in the "LongRun Technical Document" from the RiskMetrics Group

Risk Estimation



- Apply the simulation results to the cashflow map to obtain a distribution of the possible cashflow outcomes
- Plot the results in a histogram
- The following risk measures can be interpreted from the resulting plot (based on our example of procurement expenditure):
  - Average procurement expenditure
  - Standard Deviation
  - Maximum procurement expense, based on, say, a 95% confidence level *(cashflow-at-risk is the difference between the expense level at the 95% confidence and the target expenditure level)*
- Results are used in developing a procurement strategy

Example

➢ **Calculate the CfaR on total fuel expenditure for a tolling contract with fuel delivery in May03, Jun03, and Jul03**

- Cashflow Map:
  10,000 therms * $P_{gas}(t_1)$ + 15,000 therms * $P_{gas}(t_2)$ + 19,000 therms * $P_{gas}(t_3)$
  where 10000, 15000 and 12000 are demand forecast for t_1, t_2 and t_3
- Obtain future price quotes at t_1, t_2, t_3
- Calculate the 1month, 2 month and 3 month volatility values for gas prices based on historic gas prices
- Construct the covariance matrix for gas prices in a 3-month period
- Generate scenarios using Monte Carlo simulation
- Calculate the fuel expenditure under each scenario and plot out the results
- Calculate the CfaR at 95% confidence level based on the simulation results

9

Attachment 7 – Presentation of Henwood Energy Consultants

Henwood

Risk and Resource Planning

An overview of the application of risk management principals and state-of-the-art analytical techniques to the resource procurement process

Presented to:

The California Public Utilities' Commission

23 April 2003

Richard Lauckhart

Page 1

Henwood

HENWOOD…

- Provides software for electric industry analysis
- Provides data for electric industry analysis
- Provides consulting in electric industry analysis
- Particularly focused on Risk Analysis in the electric industry

Henwood

Our Subject Matter

- Fundamental risks faced by utilities
- Direct Cash Flow Risks that can be quantified and analyzed
- Not indirect Risks
  - Regulatory Risk
  - Legal Risk
  - Technology Change Risk
  - Departing Load Risk/Competitive Risk
  - Human Risk
  - Safety Risk

Henwood

Value at Risk vs. Cash Flow at Risk

(A definitional issue)

	VaR	CFaR
Type of Assets	Liquid, trading	Illiquid, for physical delivery
Position Value Metric	Asset Market Value	Sum of Cash Flows
Portfolio Risk Metric	Maximum expected loss from present (or benchmark) value with X% confidence	Maximum expected loss from benchmark value with X% confidence
Time Horizon	Days	Months, Years
Valuation Methods	Mark to Market	Mark to Model
Estimation Methods	1. Covariance 2. Monte Carlo	1. Monte Carlo 2. Weighted Scenarios

![Henwood]

Utility Risk Valuation

The attributes below and prior table demonstrate "Cash Flow at Risk" is the right measure

- Utilities have generation assets that are
  - Complicated
  - Face illiquid markets for their attributes
  - Associated with significant market volatility
- Generation assets are subject to forced outage or rainfall variation that are not easily hedged
- Utilities have retail load assets/revenue streams that are subject to weather caused volatility and are not easily hedged or sold
- Utilities have QF and other bilateral power contracts that are not liquid and which may be subject to uncertain availability (e.g. wind)
- Utility Risks are generally perceived to relate to extended time periods (e.g. months and years rather than risk associated with a change in value between today and tomorrow)
- Utility risk is generally measured in cash flow volatility rather than "mark to market" of a financial product

Henwood

Key Risk Drivers for Utilities

- Load Volatility
- Fuel Price Volatility
- Spot Market Price Volatility
- Hydro Generation Quantity Volatility
- Emission Cost Volatility
- Power Plant Availability

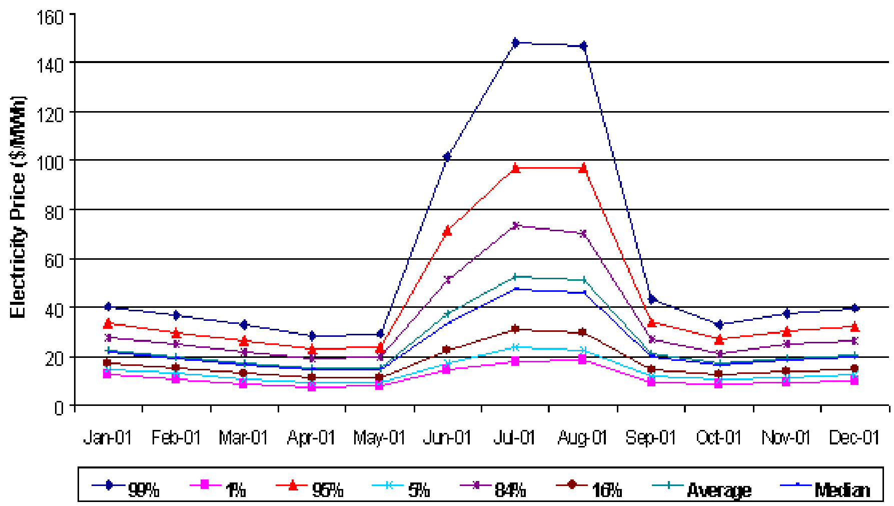
Henwood

Modeling Key Drivers

- Develop expected levels of key drivers
  - E.g. load, gas price, spot electricity price, hydro, etc.
- Develop volatility parameters for these drivers
  - Short Term parameters
    - Normal, lognormal, Markov Regime Switching, etc. as appropriate
    - Mean Reversion
    - Correlation Factors
  - Long Term
- Run large number of iterations using Monte Carlo

Henwood

Results of Markov Regime-Switching Mean Reversion Model Seasonal Electricity Price Distribution

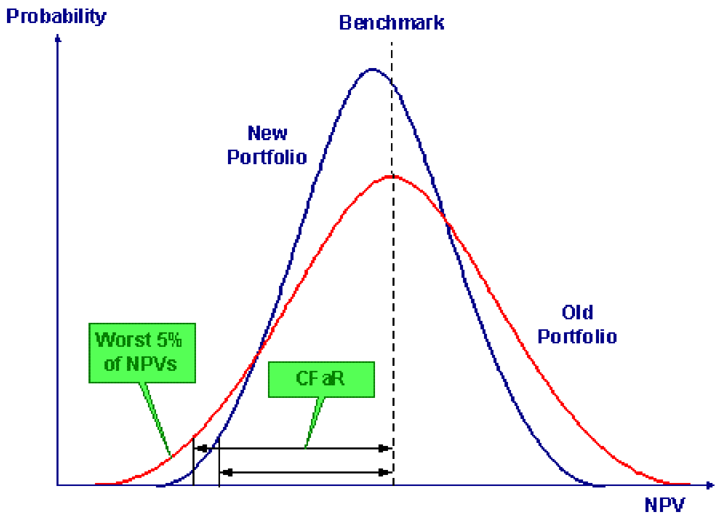


Henwood

How is Cash Flow at Risk Computed?

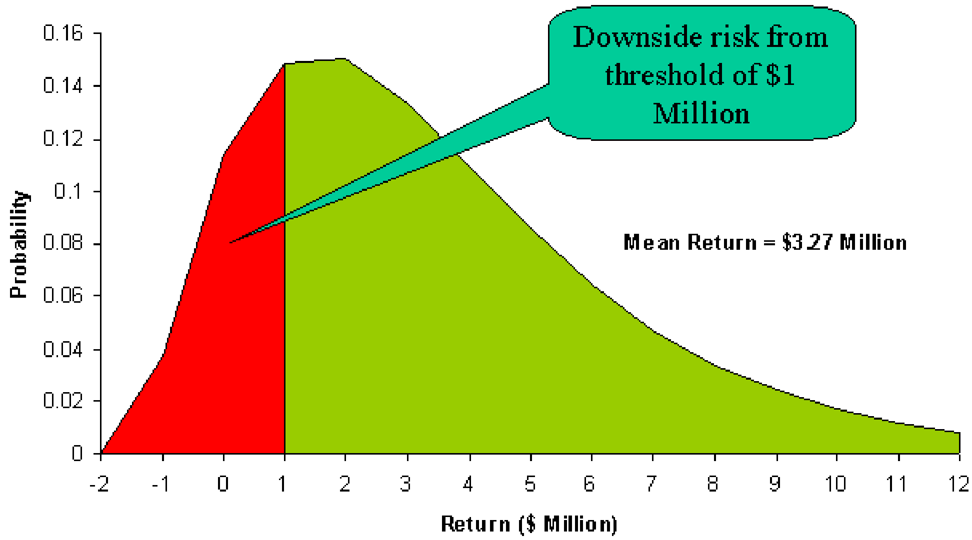
- Simulate the uncertain key drivers for a number of iterations
- Compute the utility operating results for all the iterations
- Compute the NPV of each iteration
- View the results as a probability density

Cash Flow at Risk- different levels of risk



Risk Measures

Cash Flow at Risk – Downside

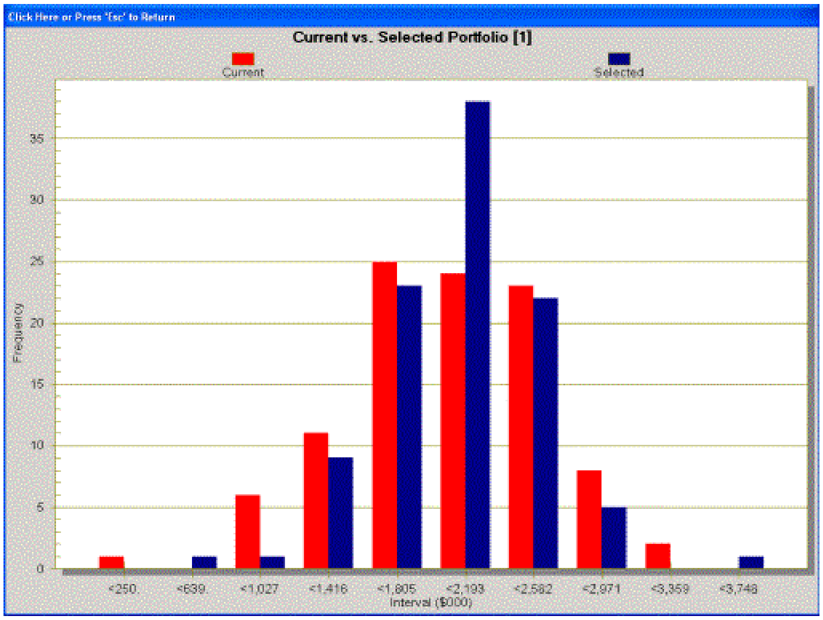


Uses of Distribution of Cash Flow

- Monitor changes (like a trading group does) in the cash flow due to:
  - Changes in expected spot prices
  - Plant breakdown
  - New transactions or power plants
- Evaluation of possible new transactions/contracts, etc.
- Rate considerations/budgeting

Henwood

Example Use – Possible Portfolio Change



Summary

- "Cash Flow at Risk" is the right measure to use for utilities
  - "mark-to-market" risk analysis associated with trades only provides part of the picture (the easy part)
  - Monte Carlo simulation of key risk drivers for Utilities is needed

- Use to
  - Monitor changes occurring over the indicated time horizon
  - Evaluate changes to portfolio (e.g. IRP)
  - Address rate considerations and budgeting (e.g. Tariffs)
  - Develop a hedging program that deals directly with uncertainty of complex assets

Attachment 8 – Presentation of Pacific Gas and Electric Company

PG&E Transition to a Value-at-Risk Approach

- VaR Approaches
- PG&E VaR Proposal
- Implementation
- Next Steps

1

What is VaR?

What is Value at Risk? Value at Risk (VaR) is a measure of the maximum potential change in value of a portfolio with a given probability over a pre-set horizon.

What is TeVaR? To-expiration Value at Risk is a measure of the maximum potential change in value of a portfolio with a given probability over the holding period of portfolio positions.

2

Why Use VaR?

Why Use VaR? VaR answers the question: What is the maximum change in portfolio cost with x% probability over a given time horizon (e.g., the holding period of the portfolio).

How does VaR tie into Customer Risk Tolerance limit? The VaR concept introduces an industry-standard measure of how much portfolio costs can increase or decrease during the holding period within a given confidence interval (probability). This can effectively be translated into a risk for a potential rate increase.

3

What Risks Are We Trying to Measure?

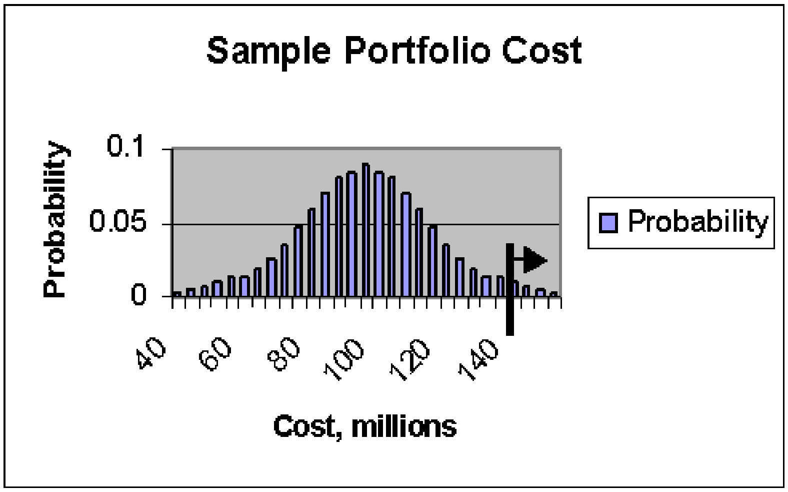
Factors that affect portfolio cost:

- Price risk
- Market positions, including options
- Location risk
- Load/demand changes
- Weather

VaR effectively represents a way to translate these risks into a probabilistic measure of cost fluctuation.

4

Sample Risk Profile and VaR



5

VaR Roadmap

- Approaches
- Periods for VaR Measurement
- Confidence Interval
- PG&E Recommended Approach and Period
- Time Horizon
- Examples

6

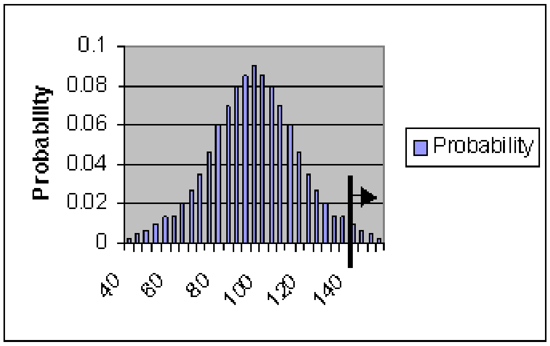
Two VaR Approaches for Consideration

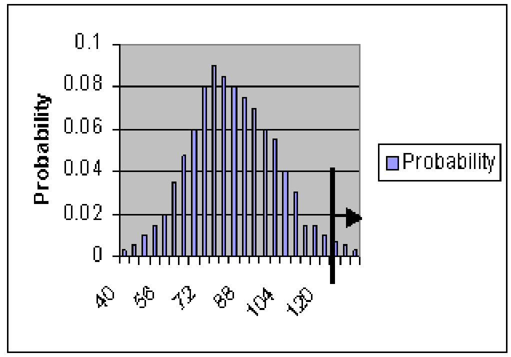
Simulated: Monte Carlo simulation (good for non-linear risk profile)

Linear: Variance-Covariance calculation (good for linear risk profile)

7

Linear vs. Non-Linear Risk Profiles





A linear risk is one where the change in the value of a position in response to a change in market price is a constant proportion of the change in the price or rate

A non-linear risk is best described by example, like an option exposure. An option's value responds differently to changes in the value of the underlying instrument.

8

Simulation Based VaR

- Approach allows for an improved representation of
  - price risk
  - market positions including options
  - location risk
  - load
  - weather (hydro)
- Allows profiles of risk drivers to be non-linear
- Varying distribution types can be handled

Implications

- Calculations take more time to set up, and results longer to produce
- Laborious to create sub-portfolio reports (e.g., load, hydro, location risk)

9

Linear VaR

- Computationally easier to seek optimal hedging strategies
- Easy to create sub-portfolio risk reports (layering in sensitivities)
- Works well for short time horizons and low volatility because distributions are almost normal

Implications

- Misrepresents variables that do not have normal distributions (such as options). Therefore, not recommended as a measure for ***total*** portfolio risk exposure.

10

Periods for VaR Measurement

Daily VaR	**To-Expiration VaR**
Assumes one day liquidation period at forward price	Assumes carrying positions to delivery, and delivery price is simulated market spot price
More applicable to a commodity portfolio that through trading can be unwound quickly	More applicable to an IOU portfolio of assets and load with inherently non-linear characteristics and spot risks such as weather and load
Acceptable for reporting of price risk, but not for volumetric or weather risk	Ideal for IOU portfolio risk limit reporting

TeVaR is effectively the same as ratepayer cash flow at risk (CFaR) if electric portfolio positions were the only ones affecting rates.

11

VaR Confidence Intervals

- **Simulated VaR**
  - Will use a downside (1-tail) risk at 95% confidence level
  - Distributions are not symmetric
- **Linear VaR**
  - Will also use a downside (1-tail) risk at 95% confidence level
  - Symmetric distributions are assumed

12

PG&E Recommended Use of VaR

- Period: To-Expiration VaR (TeVaR)
- Method:
  - Simulated (total portfolio)
  - Linear Approximation (sub-portfolio analysis, optimal hedging strategies)

13

PG&E Recommended Use of VaR

Portfolio-Level View

PG&E's portfolio contains a significant amount of non-linearity due primarily to optionality of assets, contracts and load.

Therefore, a Simulation-Based TeVaR is the appropriate measure for the total portfolio risk.

14

PG&E Recommended Use of VaR

Sub-Portfolio View, Incremental Hedging Strategies

PG&E must also analyze sub-portfolio risks and seek to mitigate risks via optimal hedging of the underlying products. Simulated TeVaR is cumbersome to use for seeking the optimal mix from scratch because:

1. Computationally intensive even for a simple optimization and would take too long
2. It is non-linear and therefore non-transparent in the way the optimal mix is chosen.
3. Only heuristic checks are possible, not validation

Given this, a linear approximation to TeVaR can still be valuable to seek an initial optimal mix and then its impact can be assessed using simulation.

15

VaR Time Horizon

Time Horizon: PG&E will use a rolling 12-month time horizon in measuring TeVaR. Reasons: Procurement plan time horizon, liquidity of forward market, increased likelihood of a good spectrum of price volatility data, risk measure assumptions tend to break down over longer time horizons

Statistical Techniques:

Simulated TeVaR: Monte Carlo simulation (total portfolio).

Linear TeVaR: Variance-Covariance calculation (sub-portfolio, incremental hedging strategies).

16

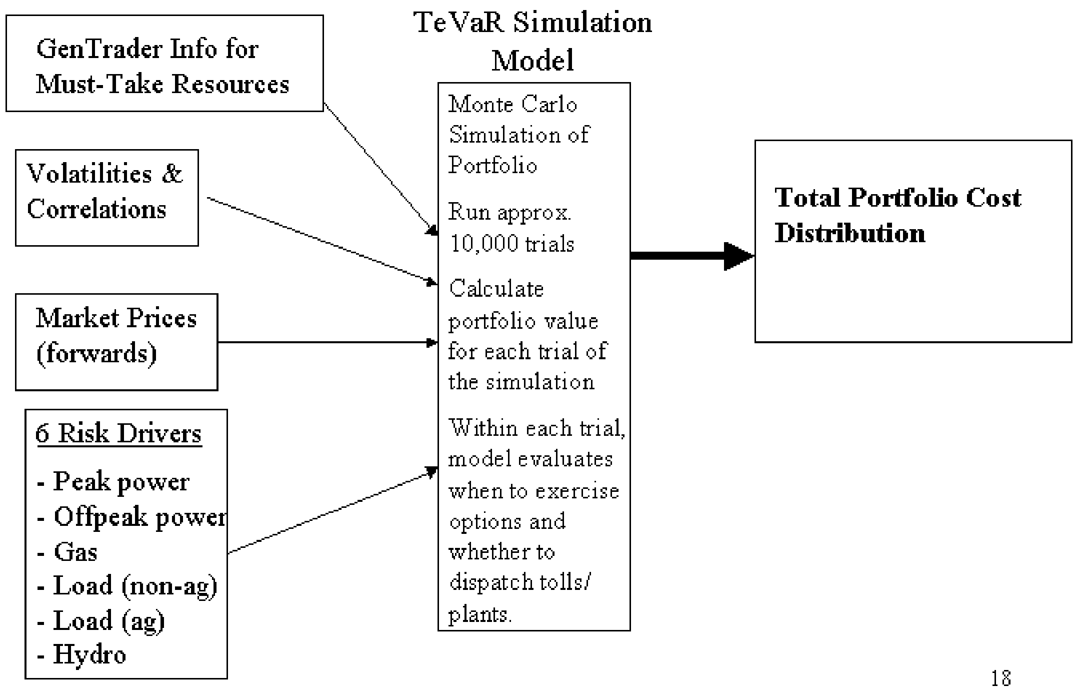
Simulated TeVaR Technique

Monte Carlo Simulation

- Varying distribution of prices, market positions, load, weather
- Calculate a portfolio value for each trial of the simulation
- Within each trial, model evaluates when to exercise options and whether to dispatch tolls / plants

17

Schematic – Simulated TeVaR



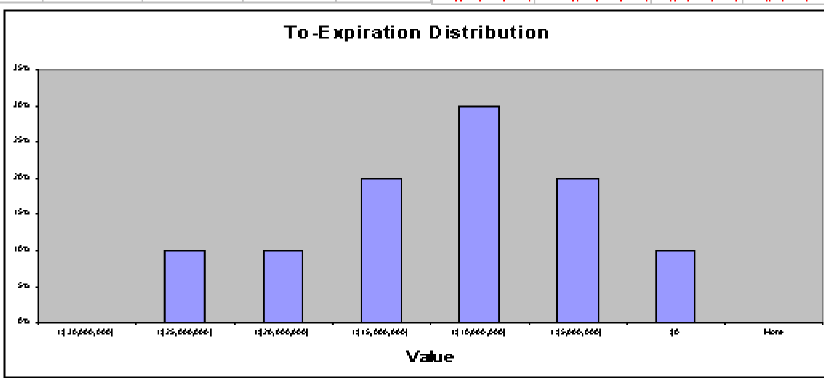
Sample Simulated TeVaR Calculation

Example Simulated TeVaR Calculation incorporating Load Variability								
Today	4/23/2003							
# of Trials	10							
			Price Volatility	Volumetric Stdev			Expiration Price	Expiration
	Fwd Price	Distribution			Trading Days	# Yrs		
NP-Jun-03	$50.00	Lognormal	67%	-	38	0.15	26%	
NP-Jun-03	$60.00	Lognormal	78%	-	60	0.23	37%	
Gas-Jun-03	$4.50	Lognormal	55%	-	38	0.15	21%	
Gas-Jul-03	$4.00	Lognormal	63%	-	60	0.23	30%	
Load Variability Jun-03	$50.00	Normal		350,000	38	0.15		133,549
Load Variability Jul-03	$60.00	Normal		150,000	60	0.23		71,919
Correlation Matrix	NP-Jun-03	NP-Jul-03	Gas-Jun-03	Gas-Jul-03	Load Var Jun-03	Load Var Jul-03		
NP-Jun-03	100%	75%	90%	50%	0%	0%		
NP-Jul-03	75%	100%	85%	40%	0%	0%		
Gas-Jun-03	90%	85%	100%	80%	0%	0%		
Gas-Jul-03	50%	40%	80%	100%	0%	0%		
Load Variability Jun-03	0%	0%	0%	0%	100%	0%		
Load Variability Jul-03	0%	0%	0%	0%	0	100%		

19

Sample Simulated TeVaR Calculation

	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Trial 6	Trial 7	Trial 8	Trial 9	Trial 10
NP-Jun-03	$59.10	$35.83	$31.97	$62.05	$78.93	$85.53	$33.04	$41.49	$67.83	$48.69
NP-Jun-03	$92.85	$43.76	$41.29	$72.46	$85.05	$70.08	$46.04	$55.24	$70.85	$51.51
Gas-Jun-03	$13.15	$4.16	$3.20	$5.28	$6.27	$4.69	$2.51	$2.99	$6.67	$4.31
Gas-Jul-03	$5.82	$3.11	$2.96	$4.90	$5.26	$6.30	$3.11	$3.58	$4.83	$3.42
Hydro Jun-03	(38,310)	4,280	4,181	3,306	(11,400)	(115,165)	(250,132)	107,570	138,331	(277,922)
Hydro Jul-03	(93,960)	(71,162)	1,612	(86,286)	47,511	(42,439)	(28,833)	1,999	(145,903)	(136,007)
Position										
NP-Jun-03	(53,724)	(58,737)	(55,950)	(24,173)	(48,234)	(151,460)	(187,268)	30,939	67,371	(108,608)
NP-Jun-03	215,721	205,101	266,900	259,908	330,211	242,709	228,990	228,598	139,540	226,506
Gas-Jun-03	(1,898,000)	(2,296,005)	(2,380,080)	(2,257,495)	(2,388,120)	(1,659,005)	(2,788,005)	(1,780,000)	(1,488,790)	(2,150,085)
Gas-Jul-03	(3,173,000)	(3,706,005)	(3,880,080)	(3,657,495)	(3,888,120)	(3,159,005)	(4,288,005)	(3,280,000)	(2,988,790)	(3,650,085)
Value										
NP-Jun-03	($5,324,152)	($2,104,393)	($1,788,845)	($1,499,913)	($3,806,975)	($12,954,927)	($6,188,022)	$1,283,776	$4,569,995	($5,288,164)
NP-Jun-03	$20,030,095	$8,975,796	$11,019,629	$18,832,114	$28,083,205	$17,009,085	$10,522,549	$12,627,966	$9,885,962	$11,667,054
Gas-Jun-03	($24,435,740)	($9,391,447)	($7,610,130)	($11,909,990)	($16,417,803)	($7,776,295)	($6,986,039)	($5,315,869)	($9,931,261)	($9,259,651)
Gas-Jul-03	($18,458,166)	($11,524,054)	($11,473,221)	($17,926,401)	($20,446,873)	($19,917,403)	($13,317,963)	($11,755,177)	($14,437,523)	($12,491,812)
Total Value	($28,188,008)	($14,044,088)	($9,862,607)	($12,608,760)	($12,688,246)	($28,888,620)	($16,888,486)	($8,168,814)	($8,812,827)	($16,872,678)



20

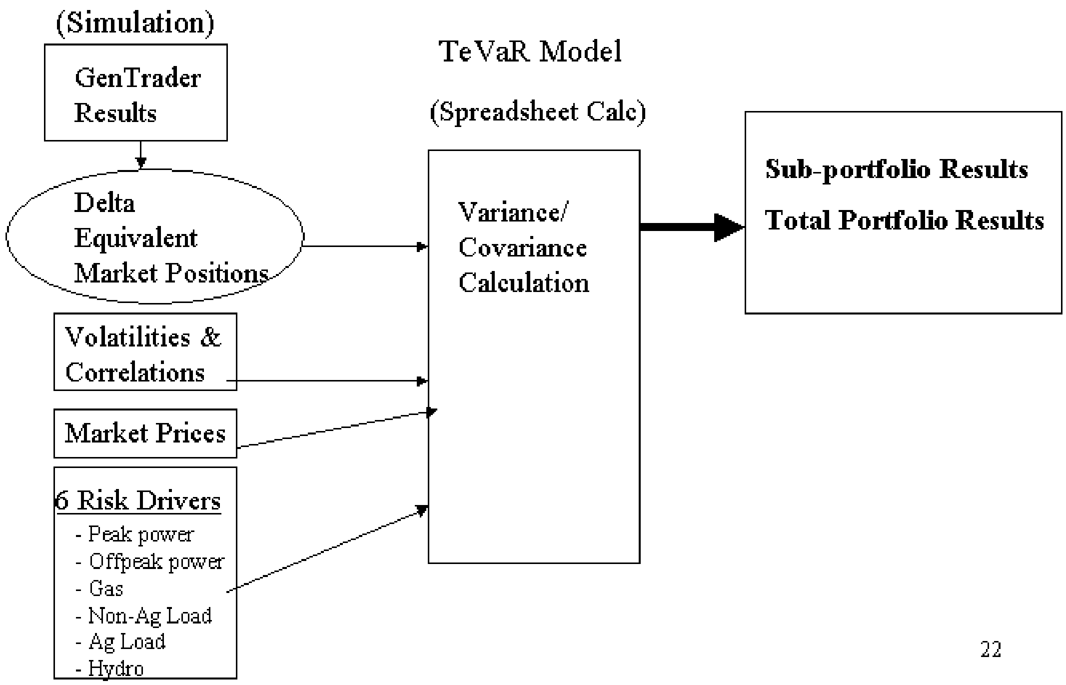
Linear TeVaR Technique

Variance-Covariance Methodology

- Options represented as delta-equivalent positions
- Works well for short time horizons and low volatility because delta-normal approximation for option values in this setting is adequate
- Calculation based on volatilities and correlations of defined positions and/or proxies

21

Schematic - Linear Approximation TeVaR



Sample Linear TeVaR Calculation

Gentrader Delta Equivalent Market Positions

Contract Volumes / Provisions

	Load	Contract #1	Contract #2	...	Contract #n	Net Position	Fwd Price	Market Volatilities
NP-Jun-03	(4,525,700)	100,000	50,000		100,000	80,000	$50.00	75%
NP-Jul-03	(4,850,250)	100,000	50,000		100,000	350,000	$60.00	82%
Gas-Jun-03	0	(1,350,000)	(500,000)		0	(3,500,000)	$4.50	60%
Gas-Jul-03	0	(1,350,000)	(500,000)		0	(4,250,000)	$4.00	50%

Simulations of Contract Values

	Trial 1			Trial 2			... Trial X		
	Contract #1	Contract #2	... Contract #n	Contract #1	Contract #2	... Contract #n	Contract #1	Contract #2	... Contract #n
NP-Jun-03	$ 9,910,000	$ 4,955,092	$ 9,910,000	$ -	$ -	$ 4,149,368	$ -	$ -	$ -
NP-Jul-03	$ 9,285,000	$ 4,642,576	$ 9,285,000	$ -	$ -	$ 5,524,096	$ -	$ -	$ -
Gas-Jun-03	$ (17,754,709)	$ (6,575,818)	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Gas-Jul-03	$ (7,853,301)	$ (2,908,630)	$ -	$ -	$ -	$ -	$ -	$ -	$ -

Calculate Price Sensitivity ... ...

Delta Equivalent Market Positions

	Load	Contract #1	Contract #2	...	Contract #n	Net Position
NP-Jun-03	(4,525,700)	45,000	40,000		42,275	(50,000)
NP-Jul-03	(4,850,250)	46,250	42,000		77,750	275,000
Gas-Jun-03	0	(607,500)	0		0	(2,000,000)
Gas-Jul-03	0	(624,375)	0		0	(3,500,000)

23

Sample Linear TeVaR Calculation

Example Linear TeVaR Calculation							
Today	4/23/2003						
1-Sided Confidence Interval	95.0%	1.64	Confidence Multiplier				
	Position (mwh, mmbtu)	Fwd Price	Volatility (Annualized)	Trading Days	# Yrs	Expiration Volatility	Price Variance
NP-Jun-03	(50,000)	$50.00	67%	38	0.15	26%	($639,126)
NP-Jul-03	275,000	$60.00	78%	60	0.23	37%	$6,170,693
Gas-Jun-03	(2,000,000)	$4.50	55%	38	0.15	21%	($1,888,760)
Gas-Jul-03	(3,500,000)	$4.00	63%	60	0.23	30%	($4,228,866)
							P
Correlation Matrix	NP-Jun-03	NP-Jul-03	Gas-Jun-03	Gas-Jul-03			
NP-Jun-03	100%	75%	90%	50%			
NP-Jul-03	75%	100%	85%	40%		Σ	
Gas-Jun-03	90%	85%	100%	80%			
Gas-Jul-03	50%	40%	80%	100%			
VaR is related to the standard deviation of the portfolio (P) value							
The portfolio value's variance is then calculated as		Variance(P) =	P' x Σ x P =	3.0987E+13			
Linear Portfolio TeVar is the standard deviation * confidence multiplier			SQRT(Variance) * 1.64				
		=	SQRT(30986784527288.4) * 1.64				
	Linear TeVaR	=	$ 9,156,202				

Sample Linear TeVaR Calculation

Example Linear TeVaR Calculation incorporating Load Variability								
Today	4/23/2003							
1-Sided Confidence Interval	95.0 %	1.64	Confidence Multiplier					
			Price Volatility	Volumetric			Expiration	Expiration
	Position (mwh, mmbtu)	Fwd Price			Trading Days	# Yrs		
NP-Jun-03	(50,000)	$50.00	67 %	0	38	0.15	26 %	
NP-Jun-03	275,000	$60.00	78 %	0	60	0.23	37 %	
Gas-Jun-03	(2,000,000)	$4.50	55 %	0	38	0.15	21 %	
Gas-Jul-03	(3,500,000)	$4.00	63 %	0	60	0.23	30 %	
Load Variability Jun-03	-	$50.00		350,000	38	0.15		133,549
Load Variability Jul-03	-	$60.00		150,000	60	0.23		71,919
Correlation Matrix	NP-Jun-03	NP-Jul-03	Gas-Jun-03	Gas-Jul-03	Load Jun-03	Load Jul-03		
NP-Jun-03	100%	75 %	90 %	50 %	0 %	0 %		
NP-Jul-03	75 %	100%	85 %	40 %	0 %	0 %		
Gas-Jun-03	90 %	85 %	100%	80 %	0 %	0 %	Σ	
Gas-Jul-03	50 %	40 %	80 %	100%	0 %	0 %		
Load Jun-03	0 %	0 %	0 %	0 %	100%	0 %		
Load Jul-03	0 %	0 %	0 %	0 %	0	100%		
VaR is related to the standard deviation of the portfolio (P) value								
The portfolio value's variance is then calculated as		Variance(P) =	P' x Σ x P =	9.4196E+13				
Linear Portfolio TeVar is the standard deviation * confidence multiplier =			SQRT(Variance) * 1.64					
		=	SQRT(94195596787824.8) * 1.64					
Linear TeVaR w/ Load Variability		=	$ 15,964,025					

25

Proposed TeVaR Implementation

- Confidence interval - Calculate risk exposure using a downside 95% CI (right-tail exposure for portfolio costs)
- Risk reporting - Simulated TeVaR for the portfolio weekly (internal risk reporting), and monthly (external reporting).
- Hedging Activities (step 1) – Calculate linear TeVaR and use results to estimate the effect of particular hedge strategies
- Hedging Activities (step 2) – Calculate simulated TeVaR for the portfolio to assess the impact of hedges in step 1
- Stress testing -Test portfolio risk exposure against specific stress scenarios for hedge effectiveness and also calibrating the two TeVaR models

26

Stress Testing

- TeVaR methodology assumes a smooth, continuous market that may "hide" truly outlier catastrophic events
- In addition to TeVaR, scenarios need to be developed to stress test the portfolio for such outlier catastrophic events
- Need to develop risk tolerance limits for these scenarios
- Need to build consensus on which scenarios one should test for and what the risk tolerance is for each scenario
- Complement TeVaR reporting with scenario test reports

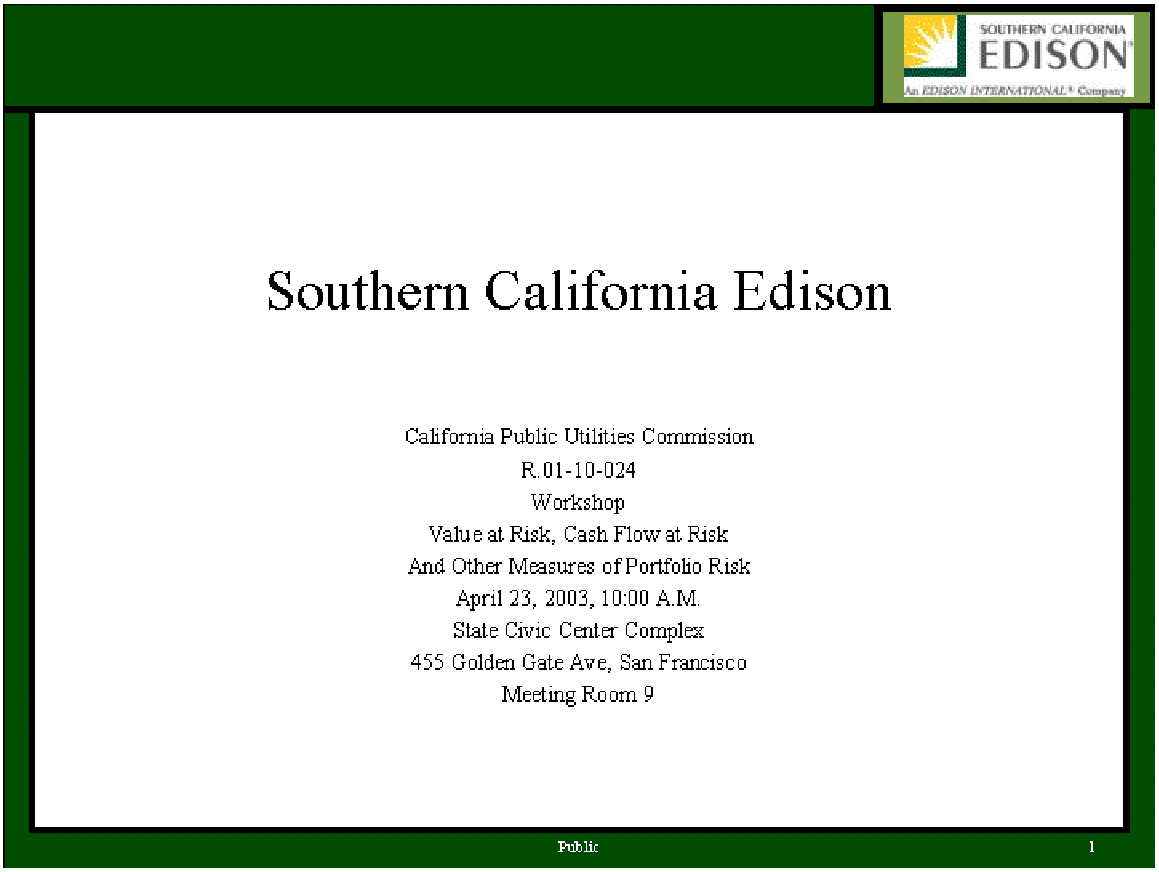
27

Status and Next Steps

- Complete development and testing of Simulation TeVaR Model, scheduled to be complete by April 30
- Submit 2004 Procurement Plan using a Simulated TeVaR and stress testing approach for risk exposure, with comparisons to Linear TeVaR and current approach

28

Attachment 9 – Presentation of Southern California Edison Company



Outline

SOUTHERN CALIFORNIA EDISON
An EDISON INTERNATIONAL Company

- Risk metric tools review
  - Parametric
  - Probabilistic
  - Statistical
- Risk model constraints
- Hybrid techniques
- Evolving methods
- Application of risk metrics
- Conclusion on use of risk tools
- A roadmap is necessary
- DWR contract cost allocation creates a wild card

Public 2

Risk Metric Tools Overview

- For purposes of this presentation let's define a risk tool as a specific algorithm or series of calculations.
  - Example: calculating the median value of a distribution yields an expected value. The median is a risk tool. It can be used on its own or in combination with other tools.
- A risk model is a representation of some real world situation, or possible outcomes, by bundling a series of risk tools (algorithms) together.
- Most risk tools can be generalized into three major categories…
  - Parametric.
  - Probabilistic.
  - Statistical.

Risk Metric Tools Overview

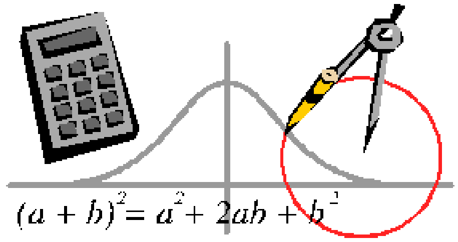
SOUTHERN CALIFORNIA EDISON
An EDISON INTERNATIONAL® Company

- Parametric: equation based models based on constant parameters.
  - This is often referred to as "deterministic" because the certain inputs always produce the same output.
    - Each X yields only one Y. ($Y = a + bX$).
  - Parameters are often estimated through regression or simple statistics.
- For simplicity purposes the parametric tools do not include distributions or distribution characteristics like μ and σ.
- Types of parametric risk tools are.
  - Cost based engineering tools like…
    - ProSym, Aurora, unit dispatch models.
  - Financial valuation tools like…
    - DCF, IRR, MIRR, EVA, MVA, pro forma,

Risk Metric Tools Overview

SOUTHERN CALIFORNIA EDISON
An EDISON INTERNATIONAL® Company

- Probabilistic: tools that simulate outcomes based on probabilities drawn from specific distributions.
- These can use deterministic equations but may run distributions of X's to generate Y's.
- Types of probabilistic risk tools are.
  - Simulated VaR, CFaR, EaR,
    - options pricing (B-S), Greeks, linear-VaR.
  - Simulations such as…
    - Monte Carlo, stress testing.
  - Stochastic models such as…
    - Mean reversion, jump diffusion, drift models, etc.

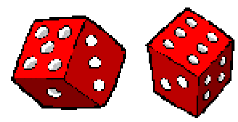


Public 5

Risk Metric Tools Overview

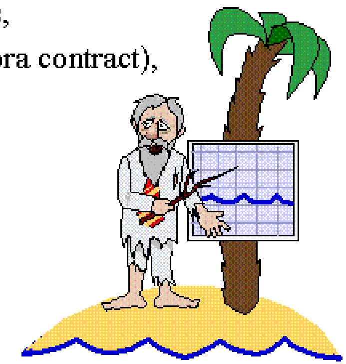
SOUTHERN CALIFORNIA EDISON
An EDISON INTERNATIONAL® Company

- Statistical: numerical values, such as standard deviation or mean, that characterizes the sample or population from which it was derived. More sophisticated tools include regression based analysis.
- Types of statistical.
  - Moments
    - Mean, variance, skewness, kurtosis,
  - Simple statistics
    - Mode, median, coefficient of variation,
  - Regression tools like
    - OLS, frontier estimation, MLE, GLS, NLS.



Risk Model Constraints

- Modeling regulated operations with industry accepted risk metrics used in merchant wholesale businesses can be misleading.
- Types of idiosyncrasies that can produce misleading results…
  - Contract capacity factor requirements,
  - Emissions constraints,
  - Start up, ramp up/down, and shut down costs,
  - Delivery specifics (such as the CDWR-Sempra contract),
  - Exchange agreements.
- Testing existing contracts yielded valuations ranging from 20% to more than 200% difference between running the models with and without these constraints.



Risk Model Constraints

- Example of valuation with and without constraints.
- As contracts contain more optionality or increased constraints, risk metrics become more difficult to apply.
- Utility portfolios often contain large amounts of optionality and operating constraints.

	Energy Revenue ($)	Total Variable Costs ($)	Total Fixed Costs ($)	Total Value ($)
Contract X, Valuation With Constraints				
Annual				
2003	$10,517,364	$8,477,417	$1,439,664	$600,283
2004	$10,120,596	$8,377,263	$1,440,357	$302,976
Total	$20,637,960	$16,854,680	$2,880,021	$903,259
Contract X, Valuation Without Operating Constraints				
Annual				
2003	$15,190,541	$11,549,655	$1,710,000	$1,930,886
2004	$13,830,555	$10,600,410	$1,710,000	$1,520,145
Total	$29,021,096	$22,150,065	$3,420,000	$3,451,031
Constraint Differential				
2003	44%	36%	19%	222%
2004	37%	27%	19%	402%
Total	41%	31%	19%	282%

Public 8

Risk Model Constraints

- User-defined input has a significant impact on results
  - Historical data encompasses a wide divergence of price and regulatory regimes
  - Market derived volatilities are dependent upon specific pricing models (e.g., Blacks vs. Black Scholes vs. etc.)
  - Bridging assumptions (e.g., Change in price caps, transition from market quotes to forecasts, etc.)
- Model sensitivity to inputs are difficult and/or not often measured
- Defining components of portfolio (e.g., DWR must-take gas requirements, QF costs, etc.)

Attachment 10 – Presentation of San Diego Gas and Electric Company

San Diego Gas & Electric Company

California Public Utilities Commission

R.01-10-024

<u>Workshop</u>

Value at Risk, Cash Flow at Risk
And Other Measures of Portfolio Risk

April 23, 2003, 10:00 a.m.

State Civic Center Complex
455 Golden Gate Ave, San Francisco
Meeting Room 9

1

Risk Management Process

1) **Quantifying Risk Position**
2) **Quantifying Risk Exposures**
3) **Calculating VaR**
4) **Using VaR to Manage Risk**
5) **Scenario: Effect of Hedge to VaR**
6) **Cash Flow at Risk**

2

Quantifying Risk Position

1) **Establish SDG&E load forecast or "initial short" position**

2) **Total all existing must-take resources which include QF contracts, 6x16 and 7x24 URG & CDWR contracts, SONGS, etc.**

3) **If initial short position exceeds must-take resources, SDG&E either dispatches CDWR units or buys power from the market; expected CDWR dispatchable volumes are determined using spread option models**

4) **If model dispatches DWR units, result is short gas position; if model purchases market power, result is short power position**

3

Quantifying Risk Exposures

Sample Positions By Month (MWh for Power, MMBtu for Gas) - as of 4/1/01												
Month	Jan-01	Feb-01	Mar-01	Apr-01	May-01	Jun-01	Jul-01	Aug-01	Sep-01	Oct-01	Nov-01	Dec-01	2001 Total
Load (On-Peak)	75,000	75,000	75,000	60,000	60,000	60,000	80,000	100,000	100,000	80,000	80,000	80,000	945,000
Load (Off-Peak)	40,000	40,000	40,000	10,000	10,000	10,000	60,000	60,000	60,000	15,000	15,000	15,000	495,000
Resources (On-Peak)*	50,000	50,000	50,000	40,000	40,000	40,000	80,000	100,000	100,000	75,000	75,000	75,000	795,000
Resources (Off-Peak)*	25,000	25,000	25,000	8,000	8,000	8,000	50,000	50,000	50,000	11,000	11,000	11,000	148,000
Resulting Energy Position (On-Peak)	-25,000	-25,000	-25,000	-20,000	-20,000	-20,000	0	0	0	-5,000	-5,000	-5,000	-150,000
Resulting Energy Position (Off-Peak)	-15,000	-15,000	-15,000	-2,000	-2,000	-2,000	-10,000	-10,000	-10,000	-4,000	-4,000	-4,000	-147,000
Resulting Gas Position	-100,000	-100,000	-100,000	-80,000	-80,000	-80,000	-300,000	-300,000	-300,000	-100,000	-100,000	-100,000	-1,480,000
SP 15 Price (On-Peak)	$ 50.00	$ 55.75	$ 66.00	$ 75.25	$ 81.75	$ 70.50	$ 56.25	$ 57.25	$ 58.75	$ 57.75	$ 56.00	$ 55.00	
SP 15 Price (Off-Peak)	$ 11.00	$ 12.25	$ 16.75	$ 41.25	$ 49.25	$ 41.25	$ 45.00	$ 18.00	$ 19.00	$ 18.25	$ 16.25	$ 15.25	
SoCal Border Gas Price	$ 5.10	$ 5.11	$ 5.40	$ 5.60	$ 5.70	$ 5.65	$ 5.64	$ 5.69	$ 5.78	$ 5.84	$ 5.70	$ 5.41	
Realized Energy Cost (On-Peak)	$ (1,250,000)	$ (1,393,750)	$ (1,650,000)	$ (1,505,000)									$ (5,798,750)
Realized Energy Cost (Off-Peak)	$ (495,000)	$ (481,750)	$ (551,250)	$ (495,000)									$ (2,023,000)
Realized Gas Cost	$ (1,060,700)	$ (1,064,880)	$ (1,080,600)	$ (895,160)									$ (4,100,810)
MTM Energy Cost (On-Peak)					$ 1,615,000	$ 1,410,000	$ 0	$ 0	$ 0	$ 288,750	$ 280,000	$ 275,000	$ 1,888,750
MTM Energy Cost (Off-Peak)					$ 591,000	$ 496,000	$ 450,000	$ 180,000	$ 190,000	$ 459,000	$ 415,000	$ 411,000	$ 1,617,000
MTM Gas Cost					$ 911,160	$ 904,160	$ 1,888,000	$ 1,841,000	$ 1,890,500	$ 1,751,100	$ 1,708,800	$ 1,616,100	$ 8,454,410
Total MTM Cost (Exposed to Market)					$ 1,817,160	$ 1,809,860	$ 1,148,000	$ 1,111,000	$ 1,180,500	$ 1,500,050	$ 1,411,800	$ 1,114,100	$ 11,966,170

*Resource quantities based on economic comparison of dispatchable capacity to forward energy prices

4

Calculating VaR - Simplified Risk Exposure Measurement

1) Mark-to-market costs are based on current forward prices for gas and power times the open short position for gas and power

2) Primary risk drivers are price volatility and correlation:

a) Higher price volatility results in higher-risk portfolio
b) Higher correlations result in higher-risk portfolio due to lack of diversification benefits

3) Example: From previous slide, make simplifying assumption that all prices are perfectly correlated with an expected 10% volatility (at a 95% confidence level) over a pre-defined exposure period of 3 days (sufficient time to cover exposure)

4) The VaR is then 10% of $23 million, or $2.3 million

5) Inputs include market prices, forward price volatility and background calculations to produce exposure volumes

5

Calculating VaR - VTE (VaR-To-Expiration) Measurement

1) The VTE model assumes holding period through delivery instead of a pre-defined exposure period; probable price movements are mapped forward over holding period to determine potential loss

Calculating VTE over holding period results in significantly larger risk measurement – depending on length of holding period, risk can be several times higher than the 3-day exposure calculation

2) The full risk model also includes the following refinements:

- **a) Load uncertainty**
- **b) Price premium above standard block energy prices to serve shaped load profile**
- **b) Correlation of price movements between gas/power and delivery periods**

6

Using VaR To Manage Risk

1) The Customer Risk Tolerance is a dollar total calculated by multiplying 1 cent/kWh to the total retail sales quantity

2) SDG&E tracks the MTM cost of open position plus actual costs to date; if prices rise such that the cost increase plus the portfolio VTE exceed the CRT, then action is taken to mitigate the possibility that year end costs will be greater than forecast + CRT:

   Rise in Actual Costs + Rise in MTM Costs + VTE < CRT

3) Possible actions :
   a) Buy physical power forward at fixed price
   b) Buy financial swaps or options on power to protect against volatility
   c) Similar action may be taken in the gas market to mitigate gas exposure

- Example of hedge to manage portfolio risk: Buy 200,000 MMBtu/month of gas for Q3 and Q4 at fixed price to reduce short gas position; this transaction reduces VTE which allows SDG&E to stay within CRT (as shown on following table)

Scenario: Effect of Hedge to VaR (200,000 MMBtu/month Q3/Q4)

Sample Positions By Month (MWh for Power, MMBtu for Gas) - w/ FTB&R Hypothetical Gas Hedge of 200,000 MMBtu/Month													
Month	Jan-01	Feb-01	Mar-01	Apr-01	May-01	Jun-01	Jul-01	Aug-01	Sep-01	Oct-01	Nov-01	Dec-01	2001 Total
Load (On-Peak)	75,000	75,000	75,000	60,000	60,000	60,000	100,000	100,000	100,000	80,000	80,000	80,000	945,000
Load (Off-Peak)	40,000	40,000	40,000	10,000	10,000	10,000	60,000	60,000	60,000	15,000	15,000	15,000	495,000
Resources (On-Peak)*	50,000	50,000	50,000	40,000	40,000	40,000	100,000	100,000	100,000	75,000	75,000	75,000	795,000
Resources (Off-Peak)*	160,000	160,000	160,000	110,000	110,000	110,000	140,000	140,000	140,000	65,000	65,000	65,000	1,785,000
Resulting Energy Position (On-Peak)	-25,000	-25,000	-25,000	-20,000	-20,000	-20,000	0	0	0	-5,000	-5,000	-5,000	-150,000
Resulting Energy Position (Off-Peak)	-8,000	-8,000	-8,000	-2,000	-2,000	-2,000	-10,000	-10,000	-10,000	-2,000	-2,000	-2,000	-47,000
Resulting Gas Position	-100,000	-100,000	-100,000	-80,000	-80,000	-80,000	-300,000	-300,000	-300,000	-100,000	-100,000	-100,000	-1,180,000
SP 15 Price (On-Peak)	$ 50.00	$ 55.75	$ 66.00	$ 75.25	$ 81.75	$ 70.50	$ 56.25	$ 57.25	$ 58.75	$ 57.75	$ 56.00	$ 55.00	
SP 15 Price (Off-Peak)	$ 11.00	$ 11.25	$ 16.75	$ 41.25	$ 49.25	$ 41.25	$ 45.00	$ 18.00	$ 19.00	$ 18.25	$ 16.25	$ 15.25	
SoCal Border Gas Price	$ 5.10	$ 5.11	$ 5.40	$ 5.60	$ 5.70	$ 5.65	$ 5.64	$ 5.69	$ 5.78	$ 5.84	$ 5.70	$ 5.41	
Realized Energy Cost (On-Peak)	$ (1,250,000)	$ (1,393,750)	$ (1,650,000)	$ (1,505,000)									$ (5,798,750)
Realized Energy Cost (Off-Peak)	$ (495,000)	$ (481,750)	$ (551,250)	$ (495,000)									$ (2,023,000)
Realized Gas Cost	$ (1,060,700)	$ (1,064,160)	$ (1,080,600)	$ (896,160)									$ (4,100,820)
MTM Energy Cost (On-Peak)					$ (1,635,000)	$ (1,410,000)	$ 0	$ 0	$ 0	$ 288,750	$ 280,000	$ 275,000	$ 7,888,750
MTM Energy Cost (Off-Peak)					$ 591,000	$ 495,000	$ 450,000	$ 180,000	$ 190,000	$ 459,000	$ 415,000	$ 411,000	$ 7,611,000
MTM Gas Cost					$ 911,160	$ 904,180	######	######	######	$ 584,100	$ 569,600	$ 541,100	$ 8,641,110
Total MTM Cost (Exposed to Market)					$ 3,137,160	$ 2,809,180	$ 1,440,800	$ 1,083,800	$ 1,841,100	$ 1,331,850	$ 1,264,600	$ 1,227,100	$ 18,181,970
*Resource quantities based on economic comparison of dispatchable capacity costs to forward energy prices													

8

Scenario: Net Effect of Hedge to VaR

Month	Jan-09	Feb-09	Mar-09	Apr-09	May-09	Jun-09	Jul-09	Aug-09	Sep-09	Oct-09	Nov-09	Dec-09	2009 Total
UNHEDGED													
Total MTM Cost (Exposed to Market)	$ -	$ -	$ -	$ -	$ 3,197,980	$ 2,303,180	$ 3,263,000	$ 3,223,000	$ 3,280,500	$ 2,500,050	$ 2,429,300	$ 2,324,900	$ 22,966,170
HEDGED													
Total MTM Cost (Exposed to Market)	$ -	$ -	$ -	$ -	$ 3,197,980	$ 2,303,180	$ 2,140,300	$ 2,025,300	$ 2,124,300	$ 1,331,850	$ 1,234,800	$ 1,240,100	$ 18,153,970
EFFECT OF HEDGE													
Reduction to MTM Exposure	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,127,200	$ 1,197,200	$ 1,156,200	$ 1,168,200	$ 1,193,200	$ 1,084,200	$ 6,812,200
Sample VFE Factors					15%	20%	35%	40%	40%	35%	35%	40%	
Reduction to VFE	$ -	$ -	$ -	$ -	$ -	$ -	$ 394,520	$ 454,880	$ 462,480	$ 408,870	$ 338,120	$ 433,680	$ 2,559,150

9